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# Research Progress Report: Buffalo-- Antelope Range Field Station : Newell-- U.S. Irrigation and Dryland Field Station : Cottonwood-- Range Field Station : Presho-- Reed Ranch Field Station

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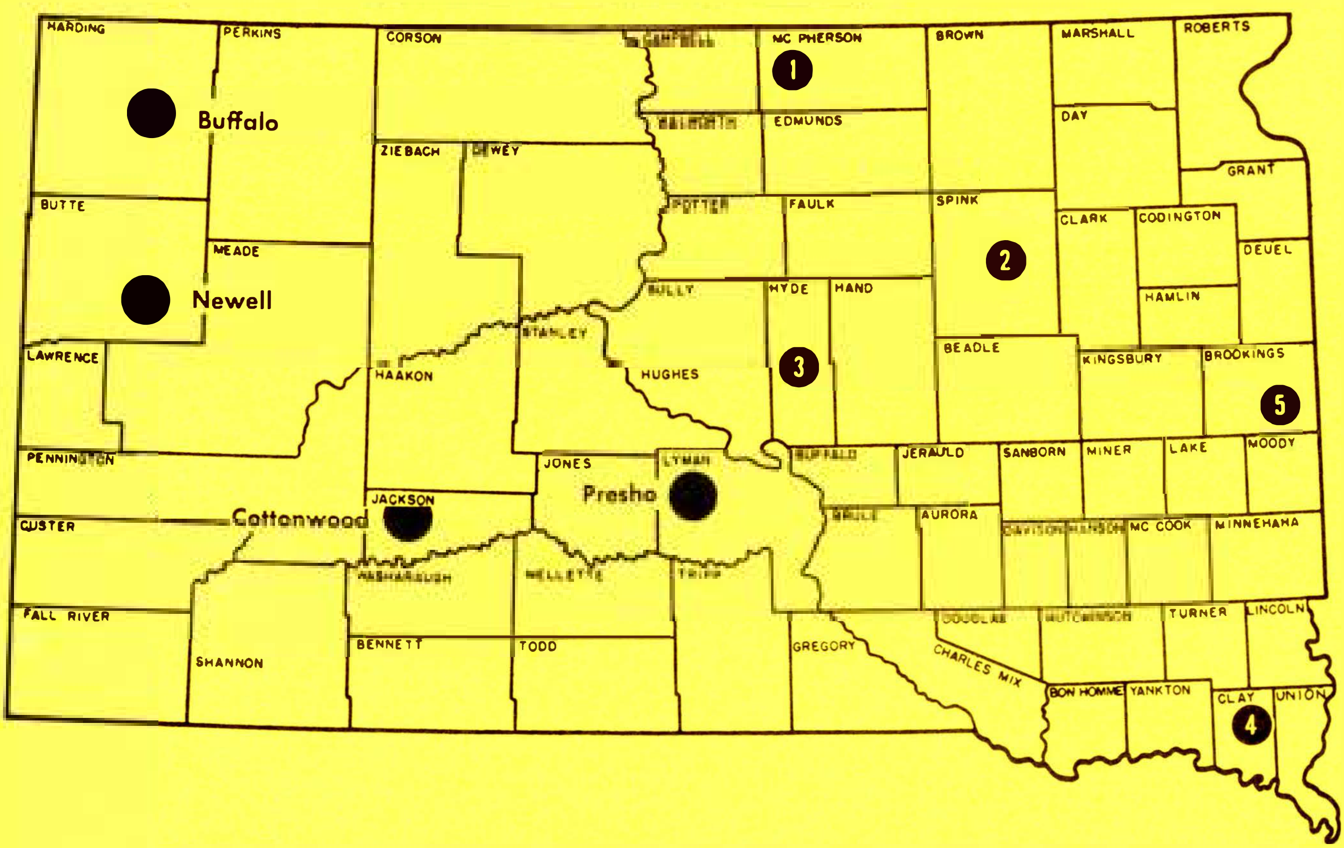
# RESEARCH PROGRESS REPORT

## BUFFALO–Antelope Range Field Station
## NEWELL–U. S. Irrigation and Dryland Field Station
## COTTONWOOD–Range Field Station
## PRESHO–Reed Ranch Field Station




Agricultural Experiment Station
South Dakota State University
Brookings

AGRICULTURAL EXPERIMENT STATION

South Dakota State University

Brookings, South Dakota

Orville G. Bentley, Director A. L. Musson, Ass't Director

This progress report summarizes the research conducted at the Cottonwood, Presho, Buffalo, and Newell substations of the South Dakota Agricultural Experiment Station. The area of each of the substations has its own specific problems or differences as far as agricultural production is concerned, but they also have some similar problems. These four stations are west of the Missouri River in widely scattered locations.

Results shown are not necessarily complete nor conclusive. Interpretations given are tentative because additional data resulting from continuation of these experiments may result in conclusions different from those based on any one year.

The report for each area will be found on the pages indicated:



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Other permanent substations making up the network of eight covering the entire state as indicated on the South Dakota map on the cover are:

1. McPherson County. North Central Research Station, Eureka.
2. Spink County. Irrigation Research Farm, Redfield.
3. Hyde County. Central Research Station, Highmore.
4. Clay County. Southeast South Dakota Experiment Farm, Centerville.
5. Brookings County. Headquarters and the main station of South Dakota Agricultural Experiment Station of South Dakota State University are located at Brookings.

## AGRICULTURAL ADVISORY GROUP

Antelope Range Field Station
Buffalo

| | | | |
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| Benny Dollarhide | Timber Lake | Paul Garr | Isabel |
| Harold Millett | Reva | Henry Meyer | Timber Lake |
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| | | Arnold Lee | Isabel |

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The Cooperative Extension Service
South Dakota State University
John T. Stone, Director

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County Extension Agents of the Antelope Range Field Station Area

Butte County - Kenneth Leslie, Belle Fourche
Corson County - John Powell, McIntosh
Dewey County - Herb. Lippert, Timber Lake
Harding County - Roger Moul, Buffalo
Meade County - Don Klebsch, Sturgis
Perkins County - Elbert Bentley, Bison
Ziebach County - A. Rieckman, Dupree

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## Personnel

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## Contents

# INTRODUCTION

Ralph Trevillyan

The Antelope Range Field Station in Harding County in the northwest corner of the state was established in 1948 as a field station dealing with the improvement of beef cattle and the development of inbred lines.

The bull calves from the cattle breeding project are fed out and some are sold to cooperators as breeding bulls. It is from these cooperator herds that steer calves are purchased to be fattened and slaughtered for carcass evaluation of the inbred lines.

Sheep experiments consist of grazing management of ewes on winter ranges, and the problems associated with the lifetime production of ewes. Lambs and wool produced under different treatments of winter feeding and summer pasture grazing rates are being measured. The major facilities at the Antelope Station are used for these two experiments.

In times past the Game, Fish and Parks Department, and the Veterinary Department of South Dakota State College cooperated in experiments involving parasites which might be common to both cattle and antelope.

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# PROGRESS REPORT FOR PROJECT 167

C. A. Dinkel and Darrell Busch

The cattle at the Antelope Range Field Station have formed the foundation for a statewide beef breeding program since 1952 when the present inbred lines were initiated. This herd corresponds to the purebred business in industry and in conjunction with the commercial herds in which lease bulls are used, the feedlot program at Brookings, the single cross study at the Cottonwood Range Field Station and the carcass work carried on in the packing plants form a duplication of the beef cattle industry. This allows the evaluation of the effects of the mating systems carried on at the Antelope Range Station throughout the entire industry.

From a research standpoint the reasons for using inbreeding may be classified as follows:

(1) To produce lines that will be superior in their own performance,
(2) To produce lines that will be superior in crosses with other lines,
(3) To obtain information on inbreeding effects,
(4) To obtain information on heterosis or hybrid vigor,
(5) To obtain reliable estimates of the effectiveness of selection,
(6) To study methods of producing superior animals, and
(7) To obtain information on gene action.

The work at the Antelope Station is primarily oriented toward 3, 4 and 7 with secondary emphasis on numbers 5, 6 and 1. It may be obvious from the above that hardly any research of a breeding nature can be carried on without closing the herds to outside blood. Effective research measures are impossible otherwise. However, once the herd is closed the number of bulls used determines whether the inbreeding increases rapidly or not. Much of the work at the Miles City Station has been aimed at mild or slow inbreeding with maximum emphasis on selection. The work at the Fort Robinson Station emphasizes selection even more and uses breeds for the study of hybrid vigor in their crossbreeding experiment. The project at the Antelope Station fits in well with this region of the country in that it emphasizes intense inbreeding with less emphasis on selection. This type of study best fits the station, and the cattle and pastures available. The following observations regarding inbreeding may be of interest.

1. If it were not for inbreeding, we would not have our present day breeds of livestock.
2. If it were not for inbreeding, breeders would not have been able to reduce the frequency of the dwarf gene in breeds of cattle to the extent that has been achieved.
3. If it were not for inbreeding, many herds would not have influenced their respective breeds to the extent they have in the past.

The beef industry is changing and will change more in the future. When industry asks the question as to whether or not inbreeding has a place in the changing industry, it is hoped that the experiment stations will have progressed far enough to provide an answer. Dr. Oliver Willham, President of Oklahoma State University, once said "We are still much in the dark about how rapid a rate of inbreeding can be guided safely by selection. Yet the thought persists that it may have been a needless waste of time to take 70 years to do work which might possibly have been done as well in 20 or 30 years." While methods of utilizing inbreeding or inbred animals do not appear to lend themselves entirely to the present day cattle industry, if intense inbreeding proves to be a method of accomplishing 70 years' work in 20, industry will find a way to use it. The trends toward larger operations, fewer family farms, increased use of artificial insemination and indications of the practical usefulness of ova transplant all point to the possibility of incorporating more complicated methods into the beef cattle industry in the near future.

The accompanying tables provide some of the information collected on the four single-sire inbred lines (1, 2, 3, 8) and the four-sire control line (12). The control line (12) was formed from essenitally the same foundation animals as the single-sire inbred lines. Table 1 indicates the increase in inbreeding of the calves for each year of the project. It will be noted that while inbreeding increased fairly rapidly in the early years it seems to have leveled off in more recent years. It appears to be rather difficult to increase the level very much past the 30 percent level. The control line is maintained by selecting two new bulls each year with no more than two of the four used in the line being from one sire. Table 1 indicates that the level of inbreeding is not increasing enough to prevent this line from being a satisfactory control on inbreeding level. That is, this line can be considered non-inbred for comparative purposes to the single sire lines. It has been estimated that the pure breeds of cattle increase in inbreeding about 3 percent per generation, and it appears this line will not exceed that level. Table 2 indicates the average inbreeding of the cows in the line and, as would be expected, the level of inbreeding in the cows is lagging behind that of the calves.

Table 3 presents the weaning weights for the 12 years that the lines have been maintained with adjustments having been made for age and sex of calf and age of dam. It may be of interest to compare tables 1 and 3 for each line at a time in order to follow the decline in weaning weight associated with inbreeding. This decline is not uniform for all lines. The effects of environmental differences from year to year have not been removed from these data. As indicated by both the control line and the inbred lines, there is considerable year-to-year fluctuation. These large year-to-year variations make it difficult to estimate genetic improvement which may have been accomplished by the selection practiced. Averaging the first three or four years with the last three or four for the control line (line 12) gives some indication that selection has been effective. It seems apparent for the other lines (the inbred lines) that inbreeding has overpowered any selection improvements that have been made. Before many conclusions can be definitely made, a more detailed analysis which will account for the environmental variations will be necessary.

Table 4 presents the weaning weights after they have been adjusted for inbreeding of calf, as well as the other factors for which adjustment was made in table 3. In this table we should be able to better see what effects selection has had in the inbred lines since, theoretically, we have removed the effect of inbreeding of the calf. Inbreeding of the dam has not been studied in this herd and correction has not been made for this factor. Comparing the average of the first four years with the average of the last four years in an attempt to average out some environmental variations, it would appear that some selection progress has been accomplished in each of the lines. Again, this is not an accurate method of eliminating environmental or year-to-year variations but it does allow a rough appraisal.

The performance of these lines and single crosses is being tested at the Cottonwood Range Field Station. As indicated above topcrosses of the inbred bulls produced at the Antelope Station are being made in commercial herds throughout the state, and steers from these commercial herds are fed in Brookings where detailed feedlot and carcass data are collected. It is hoped that during the coming year further analyses of the post weaning and cow traits measured on the Antelope Range cattle can be conducted, and further information relative to environmental effects and inbreeding of dam effects obtained.

Table 1. Inbreeding* of Calves (%)

| Year | Line 1 | Line 2 | Line 3 | Line 8 | Line 12 (control) | All lines |
|---|---|---|---|---|---|---|
| 1953 | 7 | 15 | 15 | | | 13 |
| 1954 | 12 | 19 | 12 | | | 16 |
| 1955 | 9 | 11 | 13 | 2 | | 10 |
| 1956 | 16 | 29 | 18 | 8 | 7 | 12 |
| 1957 | 15 | 32 | 22 | 8 | 0 | 10 |
| 1958 | 18 | 28 | 24 | 6 | 2 | 13 |
| 1959 | 21 | 24 | 29 | 12 | 1 | 13 |
| 1960 | 22 | 23 | 23 | 14 | 2 | 11 |
| 1961 | 27 | 29 | 28 | 15 | 4 | 15 |
| 1962 | 30 | 30 | 29 | 18 | 4 | 14 |
| 1963 | 28 | | 31 | 17 | 4 | 12 |
| 1964 | 29 | 26 | 31 | 19 | 4 | 15 |

* Sire-daughter mating produces a calf with 25% inbreeding. Half brother-half sister produces a calf with 12 1/2% inbreeding.

Table 2. Inbreeding of Cows in Line (%)

| Year | Line 1 | Line 2 | Line 3 | Line 8 | Line 12 | All lines |
|---|---|---|---|---|---|---|
| 1953 | 0 | 2 | 2 | | | 2 |
| 1954 | 0 | 2 | 1 | | | 1 |
| 1955 | 0 | 3 | 4 | 1 | | 2 |
| 1956 | 2 | 11 | 8 | 4 | 0 | 3 |
| 1957 | 7 | 14 | 9 | 4 | 0 | 5 |
| 1958 | 8 | 12 | 9 | 2 | 0 | 5 |
| 1959 | 12 | 14 | 12 | 5 | 2 | 7 |
| 1960 | 10 | 20 | 15 | 5 | 1 | 6 |
| 1961 | 15 | 19 | 14 | 6 | 1 | 8 |
| 1962 | 18 | 18 | 17 | 6 | 1 | 8 |
| 1963 | 16 | | 18 | 7 | 2 | 6 |
| 1964 | 21 | 25 | 23 | 9 | 2 | 11 |

Table 3. Adjusted* Weaning Weight

| Year | Line 1 | Line 2 | Line 3 | Line 8 | Line 12 | All lines |
|---|---|---|---|---|---|---|
| 1953 | 469 | 429 | 394 | | | 429 |
| 1954 | 431 | 393 | 357 | | | 392 |
| 1955 | 398 | 409 | 378 | 358 | | 393 |
| 1956 | 357 | 321 | 357 | 371 | 406 | 380 |
| 1957 | 408 | 420 | 430 | 438 | 455 | 438 |
| 1958 | 391 | 429 | 406 | 394 | 430 | 416 |
| 1959 | 397 | 425 | 399 | 397 | 426 | 413 |
| 1960 | 408 | 390 | 392 | 427 | 453 | 430 |
| 1961 | 388 | 381 | 397 | 407 | 431 | 411 |
| 1962 | 424 | 398 | 401 | 437 | 446 | 433 |
| 1963 | 416 | | 416 | 447 | 447 | 440 |
| 1964 | 399 | 412 | 371 | 424 | 441 | 422 |

* Adjusted for age and sex of calf and age of dam.

Table 4. Adjusted* Weaning Weight

| Year | Line 1 | Line 2 | Line 3 | Line 8 | Line 12 | All lines |
|---|---|---|---|---|---|---|
| 1953 | 481 | 455 | 420 | | | 452 |
| 1954 | 452 | 426 | 378 | | | 420 |
| 1955 | 414 | 428 | 401 | 362 | | 411 |
| 1956 | 385 | 372 | 389 | 385 | 418 | 401 |
| 1957 | 434 | 476 | 469 | 452 | 455 | 456 |
| 1958 | 423 | 478 | 448 | 405 | 434 | 439 |
| 1959 | 434 | 467 | 450 | 418 | 428 | 436 |
| 1960 | 447 | 430 | 432 | 452 | 457 | 449 |
| 1961 | 436 | 432 | 446 | 433 | 438 | 437 |
| 1962 | 477 | 451 | 452 | 469 | 453 | 458 |
| 1963 | 465 | | 471 | 477 | 454 | 461 |
| 1964 | 450 | 458 | 426 | 457 | 448 | 448 |

* Adjusted for age, sex, and inbreeding of calf, and age of dam.

## CATTLE GRUB CONTROL

Paul H. Kohler

(Extracted from Animal Science Bulletin A.S. 64-17)

This report will cover grub control studies for the past two years. Last year on Feeder's Day a progress report was given on late season treatment for the control of grubs. Many ranchers and farmers in this area found it more convenient to treat cattle for grubs after the November 1 deadline recommended by some manufacturers. You will note from the tables on 1962-63 grub season that variable results were obtained from these late season treatments. However, it is of interest to note that in all cases in 1963 where weight gains were taken, the treated calves outgained the untreated. Some of the weight gain advantages were very small; but in the 157 calves studied at the Brookings Station, significant weight gain advantages were recorded favoring the treated calves. The untreated calves gained an average of 2.19 pounds per day over the 187 day period. The treated calves varied from an average 2.25 to 2.32 pounds per day. This weight increase of 0.06 to 0.13 pounds per day represents an advantage of 11 to 24 pounds per calf.

Range Field Station, Cottonwood

| Palpation dates | No. of calves | Dosage | Grubs/calf (avg.) 2/19 | 4/12 | No. Calves infested 2/19 | 4/12 | Grub reduction 2/19 | 4/12 |
|---|---|---|---|---|---|---|---|---|
| Treatment: | | | | | | | | |
| Trolene FM (15 mg /kg for 6 days) 1/9-14, 1963 | 121 | 90 mg/kg | 3.0 | 1.4 | 45 | 30 | 75 | 90 |
| Untreated | 54 | -- | 12.1 | 13.9 | 53 | 51 | -- | -- |

Reed Ranch, Presho

| Palpation dates: | | | 3/5 | 4/24 | 3/5 | 4/24 | 3/5 | 4/24 |
|---|---|---|---|---|---|---|---|---|
| Treatment: | | | | | | | | |
| Ruelene P.O. (12/28/62) | 15 | 7 grams | 0 | 0.2 | 0 | 2 | 100 | 98 |
| Untreated | 13 | -- | 8.8 | 10.5 | 12 | 12 | -- | -- |

The grub control studies for this past grub season are summarized in the following tables. At the Reed Ranch, Antelope Range and Cottonwood substations, early grub treatment (September to early October) was administered.

At Reed Ranch a pour-on Co-Ral treatment was used. The grub control was poor (48-15%). The 1-1/2 to 2 ounces volume per calf is quite a small amount. The insecticide was poured down the backline from the shoulders for about 18 inches. It is possible that because such a small amount of insecticide was used in treating calves with winter hair that the insecticide, spread out over this large area, was inadequate in amount to reach the skin resulting in poor grub control.

Two .25% sprays of Co-Ral were studied at Antelope Range. The calves were thoroughly wetted with a high pressure spray. Excellent horn fly control resulted and excellent grub control. The two sprays were used in an attempt to give late season fly control and a less dosage per treatment of the organophosphate to the young calves. No toxicity was noted.

At Cottonwood, one Co-Ral spray treatment of 0.375% was used. Excellent grub control resulted. Again, horn fly control was impressive.

1963-64 Grub Studies

| PRESHO: | No. of Calves | Dosage | Avg. No. Grubs/calf | | No. Calves Infested | | Grub Reduction (%) | |
|---|---|---|---|---|---|---|---|---|
| Grub Count Date | | | 2/21 | 4/1 | 2/21 | 4/1 | 2/21 | 4/1 |
| Treatment: Co-Ral 4% W/V Pour-on Treated 10/4/63. | 37 | ½ oz/cwt | 1.77 | 7.24 | 14 | 24 | 48 | 15 |
| Untreated | 21 | -- | 3.4 | 8.29 | 12 | 18 | -- | -- |
| **COTTONWOOD:** | | | | | | | | |
| Grub Count Date | | | 4/1 | | 4/1 | | 4/1 | |
| Treatment: Co-Ral .375% Spray 9/9/63 | 22 | 1 gal/head | 0.27 | | 5 | | 97 | |
| Untreated | 13 | | 9.15 | | 13 | | -- | |
| **ANTELOPE RANGE:** | | | | | | | | |
| Grub Count Date | | | 2/6 | | 2/6 | | 2/6 | |
| Treatment: Co-Ral 0.25% Spray (2 applications, 9/12 & 10/10, 1963) | 35 | 1 gal/head | 0.03 | | 1 | | 99 | |
| Untreated | 42 | | 8.12 | | 41 | | -- | |

Three systemic insecticides now on the market for beef cattle grub control--Ronnel, Co-Ral and Ruelen, give excellent control of grubs in beef cattle. Control indairy cattle is more difficult because these systemics can only be used on non-lactating dairy animals within a specified time before freshening.

The insecticides are called systemics because they are distributed inside the body of the animal. The circulatory system carries the insecticide to the site where the grubs occur.

The proper timing of systemic insecticide application is important. Only one application may be necessary, but it should be made as soon as possible after all heel fly activity has stopped. Early applications are safer and more effective than later ones. In this area, treatments are given from August to November.

Instructions printed on the labels of these products must be followed carefully in mixing and also in application.

## LONG-TIME WINTER FEEDING AND SUMMER GRAZING TRIALS WITH RANGE SHEEP IN WESTERN SOUTH DAKOTA, 1953-1959

F. R. Gartner, J. K. Lewis and W. R. Trevillyan

### Introduction

The range resource is the foundation of ranching in western South Dakota. The goal of the ranch manager is to reach and maintain maxium sustained livestock production. Two of the most important factors in achieving this goal are high range condition and proper supplementation. Native ranges can be maintained in high range condition by proper grazing management which includes careful surveillance of degree of use, season of use, distribution of livestock and kind of livestock. The most critical of these is degree of use. Practices other than grazing management may be very important in improving a given range to the desired high condition.

Proper supplementation combined with high range condition is necessary to achieve maximum sustained livestock production. In general, the value of range forage declines with advancing maturity and also varies from year to year. Dormant vegetation is usually too low in energy, protein, phosphorus, and carotene for maximum livestock production. However, supplementation of these nutrients may or may not be economical, depending on the severity of the deficiency, the cost of the supplement, and the sale value of the livestock products.

On western South Dakota ranges supplements of salt, iodine, and in some areas cobalt, may be needed throughout the year. Carotene is converted to vitamin A and stored in the animal body. The amount of storage depends on many factors, but is usually adequate for the time livestock are grazed on low carotene forage except during drought years. Protein and phosphorus supplements are usually needed at least during the winter for economical production. Protein supplements are usually composed of energy-rich feeds such as soybean oil meal, which is approximately equal to corn in energy value. Consequently, when different amounts of protein supplement are fed, different amounts of energy feed are also provided.

This study was designed to determine the effect of different degrees of grazing management in summer and different levels of protein and energy supplementation in winter on ewe and lamb production and on the range resource in northwestern South Dakota. The results presented in this paper are a progress report of the years 1953-54 through 1958-59. A detailed summary of the experiment with data through 1961 is planned for publication within the next two years.

## The Study Area

The Antelope Range Field Station is located approximately 15 miles east of Buffalo in Harding County in the northwest corner of South Dakota. This area lies within the lowest rainfall belt in the state. The average annual precipitation from 1952 through 1959 at the experiment station was 12.41 inches, while the growing season rainfall (April 1 to September 30) averaged 10.08 inches (Figure 1).

The vegetation is the northern mixed prairie type. The dominant cool-season grasses are western wheatgrass (*Agropyron smithii*) and needleandthread (*Stipa comata*); the dominant warm-season grass is blue grama (*Bouteloua gracilis*). Other common grasses are green needlegrass (*Stipa viridula*), prairie sandreed (*Calamovilfa longifolia*), prairie junegrass (*Koeleria cristata*), little bluestem (*Andropogon scoparius*) and bluegrasses (*Poa* spp.). Sedges, especially threadleaf sedge (*Carex filifolia*) and needleleaf sedge (*Carex elocharis*) are fairly abundant. Silver sagebrush (*Artemisia cana*) is conspicuous as are many native forbs.

Soils in this dry part of the Chestnut soil zone have not been leached to any great depth. Consequently, lime and other carbonates have accumulated fairly high in the soil profile. Most of the soils on the field station have fine sand incorporated in their surface horizons. The majority of these soils would be classed as a silty range soil group.[1] Other important range-soil groups found on the station are sandy, thin silty, thin sandy, panspots, and overflow.

## Experimental Procedure

In November, 1951, 300 range ewes of mixed ancestry were permanently allotted to 12 treatments by restricted randomization, considering age, weight and fleece characteristics. The 12 treatments were combinations of four winter and three summer treatments. Ewes aged two through seven years were evenly apportioned in each treatment.

During winters, the ewes grazed as a band on high condition native range deferred from grazing during the summer. They were cut into four groups each day for feeding, except that a double portion was fed on Saturday and none on Sunday. The four winter treatments were range grazing plus one of the following supplements per ewe daily:[2]

| | | | | | |
|---|---|---|---|---|---|
| Lot 1 - | 1/3 lb. | containing | 40% | protein | winter-long |
| Lot 2 - | 1/3 lb. | " | 20% | " | winter-long |
| Lot 3 - | 2/3 lb. | " | 20% | " | winter-long |
| Lot 4 - | 1/3 lb. | " | 40% | " | fed for the last six weeks of gestation |

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[1] Dyksterhuis, E. J. 1964. *My rangelands. What kinds? How good?* S. Dak. Agr. Ext. Ser. F.S. 224.

[2] In 1953-54, 1/5 pound of supplement was fed to lots 1, 2 and 4 and 2/5 pound was fed to lot 3.

Thus, the ewes in lots 1 and 2 received the same amount of supplemental feed, but those in lot 1 received twice as much supplemental protein. Although the ewes in lot 3 received the same amount of supplemental protein as those in lot 1, they received twice as much supplemental feed. The ewes in lot 4 received supplement only during the period of very rapid growth of the unborn lamb. The winter-long supplements were fed from the beginning of breeding, about November 1, to the time that each ewe lambed. The ewes in lot 4 were fed from an estimated 6 weeks before the average lambing date until each ewe lambed. During the winter prairie hay was fed at the rate of 2 1/2 lb. per head daily when snow cover prevented grazing. Following lambing, supplemental feeding was discontinued. The ewes were bred to rather uniform polled Rambouillet rams.[1] Lambing began about April 1 and was almost completed by May 1 each year. The ewes were shed-lambed in order to facilitate the collection of lambing data. The lambs were ear tagged, vaccinated, docked, the males castrated; also, the birth date, birth weight, sex of the lamb, and weight of the ewe were recorded. Prairie hay was fed free choice in the lambing pens and during storms. All groups were handled alike until placed on summer pastures about May 1 each year.

From about May 1 to November 1, 100 ewes and their lambs were grazed on fairly comparable native pastures of different size which were stocked at different intensities beginning in 1950.[2] The summer treatments were:

1. Light grazing, 580 acres stocked at the rate of 0.97 acres per ewe per month.
2. Moderate grazing, 408 acres stocked at the rate of 0.68 acres per ewe per month.
3. Heavy grazing, 254 acres stocked at the rate of 0.42 acres per ewe per month.

The number of ewes in each of the four winter treatments and three summer treatments are shown in table 1. All ewes were culled in the fall of their seventh year. Some younger ewes were culled each fall because of a serious defect, such as a bad udder, rupture, broken leg, blindness, etc. Ewes were not culled for poor production unless they failed to produce a lamb for three consecutive years. Replacements for each treatment were selected from ewe lambs produced by that treatment. Selection was made on the basis of type of birth, birth weight and weight for age. The ewe lambs were all run together and treated alike until they were returned to the experimental treatments as long yearlings just prior to breeding. During the summer when death loss occurred, the grazing rate was kept constant by the temporary addition of ewes from a small "put-and-take" flock. These ewes were removed in the fall and permanent replacement was made with a yearling ewe produced in that treatment. The production records of the "put-and-take" ewes are not included in the results.

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[1] Twelve yearling polled Rambouillet rams were purchased every 2 years from the U. S. Sheep Experiment Station at Dubois, Idaho.

[2] Results of summer grazing for 1950 through 1953 are not shown in this report. In 1951 the pastures were stocked at 2/3 the planned rate.

Table 1. Number of Ewes in Each Combined Winter-Summer Treatment
Antelope Range Field Station, 1953-54 through 1958-59

| Summer Treatment (May 1-Nov. 1) | Winter Treatment (Nov 1 to lambing) Range grazing plus: 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| | 1/3 lb. 40% winter-long | 1/3 lb. 20% winter-long | 2/3 lb. 20% winter-long | 1/3 lb. 40% last 6 wks. of pregnancy | Ewes |
| Light grazing (0.97 A/ewe/mo) | 25 | 25 | 25 | 25 | 100 |
| Moderate grazing (0.68 A/ewe/mo) | 25 | 25 | 25 | 25 | 100 |
| Heavy grazing (0.42 A/ewe/mo) | 25 | 25 | 25 | 25 | 100 |
| Total ewes | 75 | 75 | 75 | 75 | |

Well water, trace mineralized salt and a mineral mixture of equal parts salt and dicalcium phosphate, were available throughout the year.

The treatment effects were measured by lamb and fleece production, ewe and lamb weights, death loss, and value of cull ewes. Monthly weights of ewes and lambs were taken with an overnight shrink on the ewes. Lambs were weaned in the last 2 weeks of September. Ewes were sheared and the fleeces weighed individually in early June.

## Results and Discussion

In this progress report, over-all averages are presented without statistical analyses. A number of factors which may be important in ewe response -- such as age of ewe, lambing sequence and number of years on experiment -- have not been studied. These factors will be considered in the final report.

### Ewe Weight Changes:

Ewe weight changes between treatments have varied considerably during summer and winter. These weight changes were influenced by a number of factors including amount and kind of supplement fed in winter, condition of winter and summer range, extremely hot or cold weather, prolonged snow cover, and age and condition of ewes. The importance of the seasonal weight changes has not been analyzed and no table of weight gains is presented. However, some generalizations can be made.

Generally, ewe weight changes during the wintering period (November to lambing) have been proportional to the amount of supplement fed. Ewes fed two-thirds pound of a 20% supplement (lot 3) lost less weight during winter and gained less during the summer than the other lots. The opposite was true of ewes fed only during the last 6 weeks of pregnancy (lot 4). These ewes lost the most weight during the winter and gained the most during the summer.

Ewes from the heavily grazed summer pasture were in poorer condition than ewes from moderate or light grazing at the start of the winter treatments. As a result they did not lose as much weight during the winter as the other two summer lots, but they were still in poorer condition at lambing. During the summer the ewes under heavy grazing made the lowest gains; those on light grazing, the highest gains; while the gains of the moderately grazed ewes were intermediate.

Lamb Crop Born and Weaned:

Lamb crop born and weaned is expressed as a percentage of the number of ewes bred in each treatment (table 2). Although the lamb crop born was the lowest under heavy grazing, those ewes which were grazed heavily during the summer but fed the most liberal supplement during the winter (lot 3) produced an average lamb crop born of 131.3%. This was one of the highest six year averages and can be attributed to a large number of twin lambs born (table 3). The additional number of twins was probably due to the flushing effect resulting from increasing the plane of nutrition by feeding a rather large amount of supplement during the breeding season (and throughout the winter) to poor condition ewes from the heavily grazed pasture. Because of the high plane of nutrition during the winter, their lambs were rather vigorous at birth and the ewes had an adequate supply of milk. A large proportion of these lambs survived even though raised under heavy grazing during the summer. The large lamb crop born and weaned under heavy summer grazing and liberal winter supplementation (131.2 and 108.0%) is in sharp contrast to the very low lamb crop produced under heavy summer grazing and a low level of winter supplementation (113.8 and 88.3%).

With regard to winter treatment only, the lamb crop born and weaned was greatest for the high level of winter supplementation (129.2 and 103.1%) and lowest for the low level (119.2 and 87.4%). Winter lot 1 (126.7 and 97.7%) and winter lot 2 (122.6 and 95.4%) were intermediate and not widely different for all years of the study.

The lamb crop born was highest for ewes on light grazing (130.1%), lowest for those under heavy grazing (120.0%), and intermediate for those under moderate grazing (123.2%). Lamb crop weaned was, again, highest for light grazing, 98.8%. However, the lamb crop weaned was slightly greater for heavy grazing (96.6%) than for moderate grazing (92.5%).

The death loss of twin lambs was lower for heavy grazing than for either light or moderate grazing during the 6 years of the study reported herein (table 3). However, fewer twins were born or raised under heavy grazing than under the other summer treatments. With regard to winter treatments, the death loss of twins was higher for the low level of supplementation (lot 4) than for the other treatments. Furthermore, the number of twins born was considerably less at the low level of winter feeding. It should be noted here that the death loss of twin lambs is greater than desired under all treatments. However, for the purposes of this study no special lactating ration was fed. Closer examination of tables 2 and 3 indicates that the potential lamb crop weaned is greater under light and moderate grazing than under heavy grazing (considering the number of twin lambs born). The death loss of twin (and single) lambs can be reduced with good management practices, especially in the first six weeks after lambing.

Weaning Weights of Single and Twin Lambs:

Ewes fed at the highest level during winter (lot 3) weaned the heaviest single and twin lambs, while ewes fed at the low level of winter supplementation (lot 4) weaned the lightest lambs (table 2). Weaning weights of both single and twin lambs from ewes fed one-third pound of a 20% or a 40% protein supplement (winter lots 1 and 2) were about equal, and only slightly higher than those from ewes fed only the latter part of pregnancy (lot 4). Differences between winter treatments were not large, but the trend was similar to that of other measures of ewe production.

Summer grazing intensity appears to influence lamb weaning weights more than the level of protein supplement in winter. Ewes on the lightly grazed pasture weaned the heaviest singles and twins. The lightest lambs were weaned from heavy grazing, while lambs from the moderately grazed pasture were intermediate between the two. The weaning weights of both single and twin lambs from light and moderate grazing were greater than those from heavy grazing for every year of the study period.

The heaviest single and twin lambs were produced by ewes grazed lightly during the summer and supplemented heavily during the winter (86.1 and 71.2 pounds). The lightest single and twin lambs were produced by ewes grazed heavily during the summer and supplemented lightly during the winter (74.0 and 61.2 pounds). There were important interactions between winter and summer treatments as well as large yearly differences.

Lamb Production:

Lamb production, expressed as pounds of lamb weaned per ewe bred, is shown in table 4. For the average of all years and all summer treatments, ewes supplemented liberally (lot 3) were highest, ewes supplemented only the last 6 weeks of gestation (lot 4) were lowest, and the two lots fed 1/3 pound of supplement winter-long (lots 1 and 2) were intermediate and not widely different. The difference of 11.8 pounds of lamb weaned between the heaviest and lightest winter treatment appears to be important and suggests the importance of adequate energy as well as protein supplementation during the winter.

The pounds of lamb weaned per ewe bred varied widely in different years. In 1957, there was less than 7 pounds difference between winter treatments. However, in 1956 the lamb weight weaned per ewe bred for winter treatments 1, 2, 3 and 4 was 70.1, 75.2, 83.5 and 53.5 pounds, respectively. In that year the amount, kind and time of winter protein supplement appears to have been quite important.

Lamb weight weaned per ewe bred for light, moderate, and heavy grazing respectively was 77.3, 71.3 and 69.8 pounds. The differences between the extreme winter-summer treatments are of special interest. For example, light grazing and the heavy rate of winter supplementation (lot 3) produced an average of 22.7 pounds more lamb than heavy grazing in summer combined with the lightest rate of winter supplementation (lot 4) over the 6-year period. This difference emphasizes the need for an adequate plane of nutrition yearlong for range ewes; *i.e.*, plentiful forage of good quality, properly supplemented, in order to maintain body weight and to produce healthy, vigorous lambs.

## Fleece Weight:

The level of winter supplementation rather than the summer grazing intensity appears to have a greater effect on grease fleece weight than did the summer grazing intensity. For the period of this study, the ewes fed the greatest amount of protein supplement (lot 3) have had the heaviest fleeces, 10.8 pounds, whereas those receiving the least amount of supplement (lot 4) have had the lightest fleeces, 9.6 pounds (table 4). Summer grazing intensity does not appear to be closely related to grease fleece weight. Fleece data such as yield, staple length, fiber diameter and tensile strength will be reported in a future publication.

## Effect of Summer Grazing Intensity on the Vegetation:

Although the results of this study can be measured in terms of ewe production, many important changes have occurred in the vegetation which have a direct effect on ewe production. The results presented in previous figures have been limited to the years 1953-54 through 1958-59. However, the summer pastures were grazed at different rates beginning in 1950. Intensive measurements of vegetation and soils have not been conducted at this station, but observations and estimates have been made each year.

More than 55% of the annual forage production has been removed each year in the heavily grazed pasture. Range condition and forage production have continually declined. Under heavy grazing the taller, cool-season grasses have decreased in abundance, while warm-season short grasses and annual grasses and weeds have increased. Buffalograss (*Buchloe dactyloides*), not an important grass in this area, is increasing in some of the draws. Plains prickly pear (*Opuntia polyacantha*) has increased, especially in recent years. Silver sagebrush (*Artemisia cana*), which originally made up about five percent of the vegetation, has been almost eliminated. The mulch cover has practically disappeared and serious soil erosion is occurring.

Range condition and forage production have not changed appreciably under moderate grazing. Certain areas have been used more heavily than planned in some years, due primarily to weather influences. The desired utilization level in this pasture is from about 35 to 50% of the annual forage production. Silver sagebrush has been grazed closely, especially during the fall, and is decreasing. However, the mulch cover is good and soil erosion is at a minimum.

The lightly grazed pasture has improved in range condition since the beginning of the study. Because of the selective grazing habits of sheep and their habit of grazing regrowth vegetation, some small areas in this pasture have decreased in forage production. On large sheep ranges, areas of close utilization can be minimized by proper salting (to entice the ewes to lightly used areas), together with good water distribution and proper fencing.

A utilization level of less than 35% of the annual forage production has been maintained on the lightly grazed pasture. As a result, range condition has improved to excellent and forage production is near maximum.

Economic Considerations:

The cost of supplementation increases as the amount fed or the protein content is increased. A 40% protein supplement may be expected to give greater ewe production than a 20% supplement in most years when fed in equal amounts. However, when fed at the rate of 1/3 pound per head daily, the difference in the protein content of the total ration is very small and random variation may obscure the effect of the treatments in some years. The decision as to the kind, amount, level, and time of protein supplementation in a given winter will depend on production factors and economic factors. Production factors include the amount and nutritional value of the range forage, and the condition of the ewe and the weather. The economic factors include the cost of different supplemental feeds and the prices of lamb, wool and cull ewes.

An economic analysis is not included in this progress report. However, the basic production data are given so that returns can be calculated using current prices and costs. The cost of the range deterioration which has occurred under heavy grazing and the value of the range improvement which has occurred under light grazing have not been assessed. Also, the sale value of the cull ewes is not included. Any economic evaluation should take these factors into consideration.

## Summary and Conclusions

At the Antelope Range Field Station in November, 1951, 300 range ewes were permanently allotted to four methods of winter protein supplementation and to three summer grazing rates. The results presented in this paper are a progress report of the years 1953-54 through 1958-59.

The results of the various levels of winter protein supplementation were:

1. Ewes fed at the highest level (2/3 pound of 20% supplement all winter) were consistently better producers--measured in terms of lamb crop born and weaned, lamb weaning weight, lamb weight weaned per ewe bred, and grease fleece weight.

2. Ewes fed at the lowest level (1/3 pound of 40% supplement the last six weeks of pregnancy) consistently had the lowest production records.

3. Ewes fed 1/3 pound 40% supplement all winter (lot 1) were slightly better producers than those fed 1/3 pound of 20% supplement all winter (lot 2). This difference was expected since the ewes in winter lot 1 received the same amount of energy but twice as much protein as those in lot 2.

In the summer, lamb crop born, lamb weight weaned per ewe bred, and weaning weights of single and twin lambs were highest for ewes on light grazing, lowest on heavy grazing and intermediate on moderate grazing. Some of the major consequences of heavy grazing which will continue to decrease ewe production are: 1) lower total forage production, 2) change in species composition from desirable to less desirable grasses and forbs, 3) a shorter green-forage season resulting from changes in species composition, 4) reduction in ground cover with an increase in soil erosion, 5) decreased land value, 6) greater nutritional problems of ewes, 7) less ewe resistance to disease and parasites, and 8) increased risk from poisonous plants. The deterioration of pastures under continued heavy use in summer coupled with poorer ewe production make it quite obvious that heavy grazing cannot be justified economically over a long period.

Results of combined winter-summer treatments indicate the most productive ewes over the six-year period were those fed 2/3 pound of a supplement containing 20% protein, all winter, and grazed lightly in summer. The lowest producing ewes were those supplemented only the last six weeks of pregnancy and grazed heavily in summer. The large differences between ewe production under these two widely different winter-summer treatments emphasize the need for an adequate plane of nutrition throughout the year.

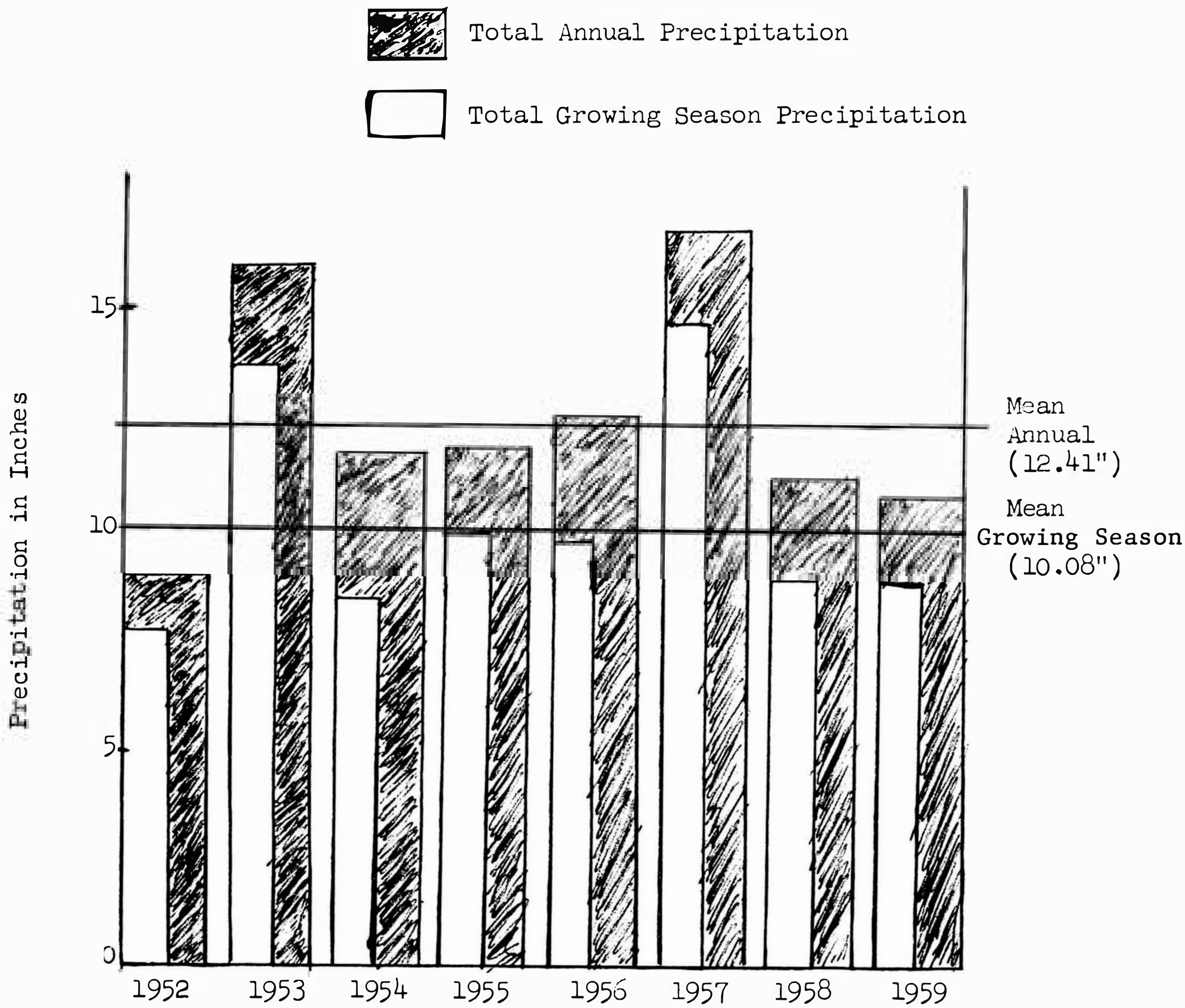


Figure 1. Growing Season (April through September) and Annual Precipitation at Antelope Range, Harding County, South Dakota, 1952 through 1959.

Table 2. Average Lamb Crop Born, Weaned, and Weaning Weights of Singles and Twins,[1/]
Antelope Range Field Station, Six Year Summary, 1953-54 through 1958-59

| Summer treatment (May 1 - Nov 1) | | Winter Treatment (Nov 1 to lambing) Range Grazing plus: 1 — 1/3 lb. 40% winterlong | 2 — 1/3 lb. 20% winterlong | 3 — 2/3 lb. 20% winterlong | 4 — 1/3 lb. 40% last 6 wks. pregnancy | Mean |
|---|---|---|---|---|---|---|
| Light Grazing (0.97 A/ewe/mo) | Lamb Crop Born, % | 132.6 | 125.5 | 133.6 | 128.7 | 130.1 |
| | Lamb Crop Weaned, % | 105.4 | 94.5 | 109.4 | 86.0 | 98.8 |
| | Weaning wt., singles, lb | 84.1 | 82.0 | 86.1 | 82.0 | 83.5 |
| | Weaning wt., twins, lb | 66.9 | 69.1 | 71.2 | 67.9 | 69.1 |
| Moderate Grazing (0.68 A/ewe/mo) | Lamb Crop Born, % | 130.2 | 124.7 | 122.7 | 114.8 | 123.2 |
| | Lamb Crop Weaned, % | 96.0 | 93.8 | 92.0 | 88.0 | 92.5 |
| | Weaning wt., singles, lb | 80.2 | 82.9 | 82.5 | 82.3 | 82.0 |
| | Weaning wt., twins, lb | 63.0 | 65.1 | 67.8 | 62.6 | 64.9 |
| Heavy Grazing (0.42 A/ewe/mo) | Lamb Crop Born, % | 116.9 | 117.5 | 131.3 | 113.8 | 120.0 |
| | Lamb Crop Weaned, % | 91.5 | 98.0 | 108.0 | 88.3 | 96.6 |
| | Weaning wt., singles lb | 79.5 | 76.1 | 77.0 | 74.0 | 76.5 |
| | Weaning wt., twins, lb | 62.0 | 62.2 | 63.1 | 61.2 | 62.4 |
| Mean | Lamb Crop Born, % | 126.7 | 122.6 | 129.2 | 119.2 | 124.5 |
| | Lamb Crop Weaned, % | 97.7 | 95.4 | 103.1 | 87.4 | 96.0 |
| | Weaning wt., singles, lb | 81.3 | 80.2 | 81.8 | 79.2 | 80.6 |
| | Weaning wt., twins, lb | 64.3 | 65.3 | 67.5 | 64.2 | 65.6 |

1/ Average weights of twin lambs include only those raised as twins (does not include twins raised as singles). Weaning weights of 17 "robbers," "bums," "runts," and 49 lambs from ewes that died before the September 1 weigh day are excluded.

Table 3. Number of Twin Lambs Born, Died, and Percentage Death Loss of Twins
for Six Years at the Antelope Range Field Station
1953-54 through 1958-59

| Summer treatment (May 1 - Nov 1) | | Winter Treatment (Nov 1 to lambing) Range Grazing plus: 1 — 1/3 lb 40% winterlong | 2 — 1/3 lb 20% winterlong | 3 — 2/3 lb 20% winterlong | 4 — 1/3 lb 40% last 6 wks pregnancy | Total born, died, and Avg death loss |
|---|---|---|---|---|---|---|
| Light Grazing (0.97 A/ewe/mo) | Twins born | 104 | 74 | 110 | 96 | 384 |
| | Twins died | 22 | 24 | 22 | 44 | 112 |
| | Avg death loss, % | 21.2 | 32.4 | 20.0 | 45.8 | 29.2 |
| Moderate grazing (0.68 A/ewe/mo) | Twins born | 102 | 90 | 80 | 60 | 332 |
| | Twins died | 32 | 28 | 24 | 20 | 104 |
| | Avg death loss, % | 31.4 | 31.1 | 30.0 | 33.3 | 31.3 |
| Heavy grazing (0.42 A/ewe/mo) | Twins born | 74 | 66 | 104 | 48 | 292 |
| | Twins died | 20 | 14 | 22 | 18 | 74 |
| | Avg death loss, % | 27.0 | 21.2 | 21.2 | 37.5 | 25.3 |
| | Total - Twins born | 280 | 230 | 294 | 204 | 1008 |
| | Total - Twins died | 74 | 66 | 68 | 82 | 290 |
| | Avg death loss, % | 26.4 | 28.7 | 23.1 | 40.2 | 28.8 |

Table 4. Average Pounds of Lamb Weaned Per Ewe Bred[1/] and Grease Fleece Weight of Ewes at the Antelope Range Field Station; Six-Year Summary 1953-54 through 1958-59

| Summer Treatment (May 1-Nov. 1) | | Winter Treatment (Nov. 1-lambing) Range Grazing Plus: 1 — 1/3 lb. 40% winterlong | 2 — 1/3 lb. 20% winterlong | 3 — 2/3 lb. 20% winterlong | 4 — 1/3 lb. 40% last 6 wks. pregnancy | Mean |
|---|---|---|---|---|---|---|
| Light Grazing (0.87 A. per ewe per mo.) | Lamb wt. weaned per ewe bred, lb | 81.2 | 74.1 | 86.5 | 67.2 | 77.3 |
| | Fleece wt., lb | 9.8 | 9.9 | 10.4 | 9.7 | 10.0 |
| Moderate Grazing (0.68 A. per ewe per mo.) | Lamb wt. weaned per ewe bred, lb | 71.2 | 73.3 | 71.8 | 69.0 | 71.3 |
| | Fleece wt., lb | 10.5 | 10.2 | 11.1 | 9.6 | 10.4 |
| Heavy Grazing (0.42 A. per ewe per mo.) | Lamb wt. weaned per ewe bred, lb | 67.5 | 70.5 | 77.2 | 63.8 | 69.8 |
| | Fleece wt., lb | 10.2 | 10.0 | 10.8 | 9.4 | 10.1 |
| Mean | Lamb wt. weaned per ewe bred, lb | 73.3 | 72.6 | 78.5 | 66.7 | 72.8 |
| | Fleece wt., lb | 10.2 | 10.0 | 10.8 | 9.6 | 10.2 |

1/ Lamb weight weaned per ewe bred is based on the weaning weight of lambs indicated in Appendix Table 3.

EFFECT OF FLUSHING AND WINTER SUPPLEMENTATION ON LAMB PRODUCTION:
A PILOT STUDY, 1956-57 THROUGH 1961-62

F. R. Gartner, J. K. Lewis, and W. R. Trevillyan

A flock of 100 ewes were summer-grazed on a 4-unit, deferred-rotation grazing system at Antelope Range. During winter, they were grazed with the rest of the ewes as a band (as previously reported) on deferred winter range. Winter supplementation consisted of 1/3 pound of a 40% protein supplement per head daily, either throughout the winter (winter lot 1 in previous report), or the last six weeks of gestation only (winter lot 4 in previous report). Half of each of these two winter lots were flushed by feeding 2/3 pound cracked corn and 1/3 pound 40% protein supplement per ewe daily on the range. During the first three years of the study, ewes were flushed from weaning until the beginning of breeding (33, 41 and 47 days, respectively). In 1959, ewes were flushed from two weeks before the beginning of breeding through the breeding season (58 days). In 1960 and 1961, ewes were flushed from two weeks before the beginning of breeding until two weeks after the beginning of breeding (28 days). The ewes were moved from summer to winter range and breeding was begun about November 1 each year. Ewes were shed-lambed in April and managed as described in the previous report. In most years the replacement yearlings were not in the flock when flushing began. Consequently, results are tabulated for older ewes only.

Lambs born alive and weaned (% of ewes at breeding) by unflushed ewes and the advantage for flushing (flushed minus unflushed) are shown in table 1. In four out of the six years flushed ewes produced more live lambs at birth than unflushed ewes ($P < .05$), especially when supplemented throughout the winter. In 1957 and 1961, the range was green until late in the fall and fewer live lambs were born to the ewes which were flushed and continuously supplemented than to the unflushed ewes. Flushed ewes, whose plane of nutrition was interrupted, gave birth to the same number of live lambs as the unflushed ewes in these two years. Although the spring and summer of 1961 were very dry, good rains were received in late August and early September, resulting in green forage until a late, killing frost. However, the winter range was completely consumed by January 1 and the ewes were kept in drylot on prairie hay with their usual supplement until lambing. The plane of winter nutrition was consequently higher than in previous years and was probably responsible for the relative high lamb production in 1961-62.

More lambs were weaned by the flushed than the unflushed ewes, especially those which were continuously supplemented (winter lot 1) in the four years when the fall season was dry prior to breeding. However, these differences were not significant.

Weaning weights were not significantly affected by the flushing treatment. Salable lamb production (pounds lamb weaned per ewe at breeding) from the flushed ewes continuously supplemented (winter lot 1) was slightly greater than from the unflushed ewes (+ 3.8 pounds), especially in the years without green forage in the fall (+ 6.7 pounds). However, salable lamb production from the flushed ewes whose plane of nutrition was interrupted, was slightly less than from the unflushed ewes.

With corn at \$40/ton and 40% protein supplement at \$100/ton it would cost \$1.20 to flush a ewe (at the level fed in this experiment) for 40 days. The additional 6.7 pounds of lamb from the ewes supplemented winterlong and flushed only in years with dry falls would be worth \$1.21 if feeder lambs sold for \$18.00 per hundred weight.

The results from this pilot study with small numbers of ewes are not conclusive. However, the data suggest that:

1. lamb crop born alive can be increased substantially by flushing ewes in dry falls, especially if an adequate plane of nutrition is maintained throughout the winter, and

2. a higher level of management is required during and after lambing to save the additional twin lambs.

Table 1. Effect of Flushing and Winter Supplementation on Lamb Production[1/]
Antelope Range, 1956-57 through 1961-62
(Ewes aged 3 through 7 at lambing[2/])
Lambs Born and Weaned

| | Difference in lambs produced, % of ewes bred (flushed minus control)[3/] | | | |
|---|---|---|---|---|
| Protein supplement: | 1/3 lb. 40% winterlong | | 1/3 lb. 40% last 6 weeks of gestation | |
| | Live lambs born | Weaned | Live lambs born | Weaned |
| | percent | percent | percent | percent |
| 1956 | (115.0) + 32.6 | (100.0) + 19.0 | (133.3) - 13.3 | (114.3) - 14.3 |
| 1957[4/] | (125.0) - 13.9 | (110.0) - 21.1 | (136.8) 0.0 | (121.1) - 31.6 |
| 1958 | (111.1) + 36.3 | (105.6) + 20.7 | (109.1) + 12.6 | ( 90.9) + 0.4 |
| 1959 | (115.8) + 36.8 | (105.3) + 31.5 | (118.2) + 16.8 | (104.5) + 10.5 |
| 1960 | (125.0) + 15.0 | (105.0) + 5.0 | (121.1) + 26.5 | ( 84.2) + 15.8 |
| 1961[4/] | (136.4) - 10.1 | (122.7) + 3.6 | (150.0) 0.0 | (130.0) - 5.0 |
| AVERAGE: (all years) | (121.4) + 17.8 | (108.1) + 9.8 | (128.1) + 7.1 | (107.5) - 4.0 |
| AVERAGE: (except '57 and '61) | (116.7) + 30.2 | (104.0) + 19.0 | (120.4) + 10.7 | ( 98.5) + 3.1 |

1/ Flushed ewes were fed 2/3 lb. corn and 1/3 lb. 40% protein supplement per head daily on range. In 1956, 1957 and 1958 ewes were fed from weaning to the beginning of breeding or 33, 41 and 47 days, respectively. In 1959 ewes were fed for 2 weeks before the beginning of breeding through the breeding season, 58 days. In 1960 and 1961 ewes were fed from 2 weeks before the beginning of breeding until 2 weeks after, 28 days.
2/ Number of ewes per treatment averaged 20 and ranged from 18 to 23.
3/ Figures in parenthesis are lambs produced (% of ewes bred) by unflushed ewes.
4/ In 1957 and 1961 the range remained green until late in the fall.

Table 2. Effect of Flushing and Winter Supplementation on Lamb Production
Antelope Range, 1956-57 through 1961-62
(Ewes aged 3 through 7 at lambing)
Salable Lamb Production

| Protein supplement: | 1/3 lb. 40% Winterlong | | 1/3 lb. 40% last 6 weeks of gestation | |
|---|---|---|---|---|
| | Unflushed | Advantage (Flushed-unflushed) | Unflushed | Advantage (Flushed-unflushed) |
| | lbs | lbs | lbs | lbs |
| 1956 | 68.7 | - 0.1 | 75.1 | -12.2 |
| 1957 1/ | 66.7 | -10.2 | 71.2 | -13.5 |
| 1958 | 82.7 | +10.4 | 69.7 | + 1.3 |
| 1959 | 80.3 | +15.3 | 80.5 | + 2.2 |
| 1960 | 64.4 | + 1.0 | 54.1 | + 4.8 |
| 1961 1/ | 95.7 | + 6.2 | 95.8 | - 2.0 |
| Average (all years) | 76.4 | + 3.8 | 74.4 | - 3.2 |
| Average (except 1957 and 1961) | 74.0 | + 6.7 | 69.8 | - 0.9 |

1/ In 1957 and 1961 the range remained green until late in the fall.

Table 3. Effect of Flushing and Winter Supplementation on Lamb Production
Antelope Range 1956-57 through 1961-62

Analysis of Variance
Mean Squares - All 6 Years

| Source of Variation | d.f. | % Lambs Born | % Lambs Weaned | Wng. Wt. Singles | Wng. Wt. Twins | Lamb Wnd. per Ewe Bred |
|---|---|---|---|---|---|---|
| Total | 23 | | | | | |
| Flushing | 1 | 808.52 | 49.60 | 0.24 | 9.62 | 0.43 |
| Winter | 1 | 28.82 | 338.25 | 4.50 | 18.72 | 182.60 |
| FW | 1 | 126.76 | 286.35 | 1.13 | 0.97 | 73.50* |
| Years | 5 | 152.56 | 390.87 | 284.45** | 221.87** | 777.65** |
| FY | 5 | 221.00 | 262.24 | 2.50 | 12.99 | 60.28* |
| WY | 5 | 189.04 | 138.57 | 17.69 | 14.07 | 52.11* |
| FWY | 5 | 149.45 | 55.87 | 7.54 | 8.68 | 9.97 |

4 Years Only 1/

| Source of Variation | d.f. | % Lambs Born | % Lambs Weaned | Wng. Wt. Singles | Wng. Wt. Twins | Lamb Wnd. per Ewe Bred |
|---|---|---|---|---|---|---|
| Total | 15 | | | | | |
| Flushing | 1 | 1666.68* | 490.62 | 0.27 | 20.47 | 32.21 |
| Winter | 1 | 147.01 | 726.30 | 1.75 | 5.64 | 255.20 |
| FW | 1 | 381.23 | 254.41 | 0.86 | 3.33 | 58.14 |
| Years | 3 | 87.87 | 181.34 | 247.51** | 189.97** | 459.17** |
| FY | 3 | 57.68 | 58.46 | 3.58 | 16.43 | 41.60 |
| WY | 3 | 42.54 | 87.20 | 2.36 | 21.59 | 54.60 |
| FWY | 3 | 139.65 | 88.41 | 6.05 | 13.20 | 15.23 |

1/ 1956-57 and 1961-62, years with green falls were omitted.
* $P < .05$
** $P < .01$

# EFFECT OF SELF-FED LAMBING RATION ON LAMB PRODUCTION

J. K. Lewis, F. R. Gartner and W. R. Trevillyan

During the winter of 1963-64, grade Rambouillet ewes were bred to Hampshire rams (beginning November 1), grazed as a band on range deferred for winter use, and fed 2/3 pound per head every other day of a supplement containing 20 percent protein until 6 weeks before the estimated average lambing date (March 1). From this date until she lambed, each ewe was fed 2/3 pound of the supplement daily. Ewes were sheared February 28. A bad storm with extremely cold weather and about 3 inches of snow hit on March 20, and prairie hay was fed for 3 days because of snow cover. No other hay was fed during the winter. Following the storm, 10 ewes were lost with symptoms resembling pregnancy disease. Treatment with molasses drench and intraperitoneal glucose injection was ineffective. Lambing began April 1 and for 8 days the drop band was fed prairie hay free-choice along with one pound of alfalfa hay, one pound of corn, and 2/3 pound of the winter supplement. Corn feeding was reduced, then stopped on April 10.

After lambing, one-half of the ewes in each summer grazing treatment were self-fed a pelleted ration containing approximately 2/3 prairie hay and 1/3 barley[1] while the other half was given free access to prairie hay and, for the first 3 days after lambing, was also fed 2/3 pound per head daily of the winter supplement. The first ewes left the lambing pens on April 10. The weather was very good after this date and hay feeding to the control ewes was stopped on April 15 because they were leaving the hay and chasing the green grass. These ewes lost condition rapidly during this period.

The self-fed ewes consumed 8 to 9 pounds per head daily of the pelleted ration in the lambing pens and ate about 6.4 pounds per head daily for the first week after they were turned on range. The ewes were removed from the self-feeders when they were placed on summer pasture May 7. Consumption for the feeding period averaged 153 pounds per ewe.

Dog ticks (Dermicentra andersonii) were noticed during the last week of April. By the last of April the ticks were present in epidemic numbers--covering the sagebrush, saddle horses, and cattle, as well as the sheep. Many lambs died and many that were sick recovered slowly. Typical symptoms were lameness in one or more legs, general inactivity and weakness. Some lambs died while they were still in good condition, others became quite emaciated. Post mortem examinations showed an arthritis with an increase in joint fluid. The bacteria cultured from this fluid were mostly staphylococci with a few colonies of Corynebacterium pyogenes which is frequently found in joint infections and abscesses. One lamb was found to have multiple abscesses throughout the skeletal muscles and viscera from which staphylococci were cultured. These organisms may have entered through the tick bites. There was no evidence of viral arthritis, white muscle disease or internal parasites. Lambs that were given penicillin injections responded slowly if at all.

The effect of the self-fed lambing ration on lamb production is shown in the following table. Lamb losses were high in both control and treated lots. How-

[1] The pelleted ration contained 62.0% prairie hay, 30.5% barley, 5% cane molasses and 2.5% bentonite. The protein content was 9.03% with 7.19% moisture.

ever, death loss of both singles and twins was substantially reduced by the self-fed ration; weaning weights were increased and salable lamb production was increased 17.2 pounds per ewe fed. With prairie hay at $20 per ton, supplement (20% protein) at $70 per ton, the pelleted ration at $45 per ton, and feeder lambs at $21 per hundred, the self-fed ewes returned 43 cents more per head than the controls. The same beneficial effect could probably be achieved at less cost by hand feeding suitable homegrown feeds. This trial is being repeated in 1964-65.

Effect of Self-fed Lambing Ration on Lamb Production
Antelope Range, 1963-64

| | Lactation Ration (Lambing to May 7) | |
|---|---|---|
| | Control (Prairie Hay) | Self-fed Pelleted Ration |
| No. ewes fed[1] | 187 | 185 |
| No. twins born[2] | 76 | 106 |
| Twins died, birth to May 7, % | 45 | 24 |
| Twins died on summer range, % | 21 | 18 |
| No. singles born[3] | 148 | 130 |
| Singles died, birth to May 7, % | 16 | 8 |
| Singles died on summer range, % | 3 | 3 |
| Death loss, all lambs birth to weaning, % | 33 | 24 |
| Weaning weight, singles, lbs | 69.9 | 75.9 |
| Weaning weight, twins, lbs | 56.7 | 59.6 |
| Weaning weight, twins raised single, lbs | 65.1 | 73.4 |
| Salable lamb production, lbs Weaned per ewe fed | 55.1 | 72.3 |
| Feed consumed, lbs per ewe: | | |
| Hay | about 19 | -- |
| Supplement | 2 | -- |
| Self-fed ration | -- | 153 |

1 Only ewes with live lambs.

2 Lambs born twins with both twins alive after lambing; does not include any lambs that were dead, crippled, or deformed at birth.

3 Singles born alive; does not include any lambs that were dead, crippled or deformed at birth.

## EFFECT OF INJECTABLE IRON AND VITAMIN A ON LAMB SURVIVAL

F. R. Gartner, J. K. Lewis, and W. R. Trevillyan

The long term intensity of grazing and winter supplementation studies (see previous report) were redirected in the fall of 1962, and the ewes were reallotted to summer grazing treatments by restricted randomization considering previous treatment and age. No differential treatments were applied to the ewes during the winter in order to minimize residual effects from previous treatments. The ewes were grazed as a band on range deferred for winter use and every other day were fed 2/3 pound per head of a supplement containing 20 percent protein until 6 weeks before the estimated average lambing date; they were then fed 2/3 pounds per head daily of the supplement until lambing. Ewes were shed-lambed beginning April 1. Prairie hay was fed free-choice in the lambing pens and on the range when needed during storms. No supplement was fed after lambing.

Within 24 hours after birth, every other lamb was given two injections, one with 2.0 cc injectable iron (50 mg elemental iron per cc) and one with 0.5 cc vitamin A (500,000 I.U. per cc). Of 263 twins, 35% of the untreated and 41% of the treated died by May 9. Of 239 singles slightly over 8% were lost in both treated and untreated groups. Severe weather after lambing increased the stress on the weaker lambs. Essentially no difference was observed between the treated and the untreated lambs in survival or in weaning weight.

## Antelope Range Tree Plantings

Paul E. Collins

A windbreak was planted in 1957 to the north and west of the farmstead area. Initial survival was relatively good due to a favorable moisture supply. However, a high percentage of the Eastern redcedar and Ponderosa pine were killed by an unfavorable winter. Since that time unfavorable moisture conditions and root competition from established trees have prevented good transplanting success. To date a 100 percent stocking of the evergreens has not been achieved. Chinkota elm, Russian olive and lilac have performed satisfactorily, and well-established Eastern redcedar and Siberian peashrub have given good growth.

In 1960, two spacing study plots utilizing Chinkota elm were planted. Compared were between-row spacings of 12 feet and 24 feet. Spacing in the row was identical - 12 feet between trees. Some transplanting in succeeding years has been necessary to obtain 100 percent stocking. Growth of all established trees has been satisfactory.

## AGRICULTURAL ADVISORY GROUP

### Range Field Station
### Cottonwood

| | | | |
|---|---|---|---|
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| Francis Guptill | Interior | Dale Volburg | Okaton |
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| Merle Temple | Cottonwood | Lee Jacobs | Allen |
| Ohmar Cook | Cottonwood | Cecil Williams | Long Valley |

* * * * * * * * *

## THE COOPERATIVE EXTENSION SERVICE
South Dakota State University
John T. Stone, Director

### County Extension Agents of the Range Field Station Area

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* * * * * * * * *

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## Contents



## INTRODUCTION

The Range Field Station at Cottonwood has a greater variety of experiments in progress than any other station. The Agronomy Department tests small grain varieties, grass varieties, and occasionally corn and sorghum. The legume nursery contains many varieties of alfalfas and other legumes being tested for the western part of South Dakota.

The Animal Science Department has work in progress in beef cattle breeding, cattle on western pastures involving different intensities of grazing--heavy, moderate, and light. This station is centrally located in the range area of western South Dakota. Several plots demonstrate new practices of range renovation such as interseeding and ripping. Watershed runoff studies have now been initiated on the long-time "rates of grazing" pastures. These experiments will reveal the effect of heavy, moderate or light grazing rates on the amount of runoff from such pastures.

Calves wintered with shelter in small lots are compared to calves wintered on the open range. Pesticides for cattle and the means of application--pour on, back rubbers, and sprays--are tested.

Other departments of the college--Horticulture, Agricultural Engineering, Plant Pathology, and Entomology-Zoology--actively engage in experiments which have immediate usefulness and high demonstrational value.

# THE EFFECT OF LEVEL OF WINTER SUPPLEMENTATION AND INTENSITY OF SUMMER GRAZING ON STEER GAINS ON NATIVE RANGE

James K. Lewis, F. R. Gartner, L. B. Embry and John Nesvold

(This report is from Animal Science Department Report No. AS 64-10)

The experiments summarized in this report were conducted at the Cottonwood Range Field Station, 75 miles east of Rapid City, where an intensity of grazing study on native range has been in progress since 1942. Six native pastures were grazed heavily, moderately, or lightly from May through November by cows and calves through 1959. The results of these studies are reported elsewhere. Since 1959 steer calves have been used to study the effect of winter supplementation and intensity of summer grazing on steer gains on native range. Stocking rates with steers were similar to those obtained with cows and calves.

The average annual precipitation at the Cottonwood Range Field Station is 15.1 inches. The predominant range soil group is clayey, and the major grasses are western wheatgrass, blue grama and buffalograss. At the beginning of the grazing study in 1942, all of the pastures were in good range condition. Under heavy grazing range condition declined to low fair and high poor in rep 1 and 2, respectively, by 1959. The moderately grazed pastures were still in good range condition and the lightly grazed pastures had improved to low excellent range condition. Since 1959 western wheatgrass, the most abundant grass in high range condition, has decreased from about 40% by weight in light grazing to about 15% in 1963. In turn short grasses, dryland sedges and annuals have increased. Similar changes have occurred in areas permanently excluded from grazing. The reasons for these changes are being studied and may be due in part to five consecutive years of below normal precipitation in March and April (table 1). The effect of spring drought on cool season western wheatgrass was intensified by competition from japanese brome, a winter annual grass. Japanese brome appears to require about 2 inches of precipitation in September or October followed by good fall growing conditions to develop dense populations which are fiercely competitive. Such populations developed in each of the years from 1960 through 1963, although the density of the japanese brome was somewhat lower in 1961 following the dry fall of 1960. Plant pathogens and parasites appear to have been involved, possibly as secondary factors, in the decline of western wheatgrass.

Precipitation for the past five years is shown in table 1. While the yearly totals are near or above average for each year except 1961, the range has had the appearance of severe drought for the last three years.

The steer studies from 1959-60 through 1962-63 have been conducted as three factorial experiments with different levels of winter supplementation and different intensities of summer grazing. Average daily gains for different periods were analyzed by least squares, and the corrected means separated by Duncan's Multiple Range Test are presented in the tables. Since there were no significant winter x summer interactions in any of the experiments, the summer intensity of grazing studies and the winter level of supplementation studies will be discussed separately. One might have expected steers with high winter gains to maintain their weight advantage during the summer, if they were lightly grazed on pastures in excellent range condition, but to lose this advantage, if they were heavily grazed on pastures in fair or poor range condition. Unfortunately, it was impossible to test this hypothesis because of the very poor growing conditions for cool season grasses which were encountered during these studies.

### Effect of Intensity of Summer Grazing on Steer Gains

Ten record steers were allotted to each grazing rate in each replication in 1959 and nine record steers were used in each year afterward. Average daily gains are based on the record steers and they remained on the pasture throughout the season from mid-May to mid-November each year. Put-and-take steers were added or removed to control the degree of utilization by visual estimate to less than 35% of the current forage production removed under light grazing, 45 to 55% under moderate and over 60% under heavy grazing. Since 1960, utilization has been near the upper limit of the planned rate. Steers have access to trace mineralized salt and a 1:1 mixture of dicalcium phosphate and salt. Stocking rates and gain per acre by grazing treatment, rep and year are shown in table 2. In every year except the dry year of 1961 gain per acre was highest under heavy grazing. However, maximum gain per acre does not necessarily mean maximum net return per acre since such things as range deterioration, animal connected costs and individual animal values are not considered.

Summer steer gains for different periods under different intensities of summer grazing for experiment 1 (1960), experiment 2 (1961 and 1962) and experiment 3 (1963) are shown in tables 3, 4, 5 and 6. Since steer gains decline rapidly in the fall, summer and yearlong average daily gains are shown to three different weigh dates in each table.

In experiment 1 (1960) the steers on light and moderate grazing gained significantly more than those on heavy grazing, but the difference between light and moderate grazing was not significant. This suggests that the latter two groups of steers had plenty of good quality forage while those in heavy grazing did not. During late August the range began to cure on the uplands but remained green in the draws and grazing was concentrated on the green areas. In September and October steer gains appeared to be closely related to the acreage of draws in each pasture rather than to the grazing intensity. Thus, summer and yearlong gains to October and November in heavy grazing rep 1 with a large acreage of draw were equal to or higher than moderate grazing rep 2 with a smaller acreage of draw or than moderate grazing rep 1 which has no draw at all.

In subsequent years, soybean oil meal was fed every other day at the rate of 1 pound per head daily to steers in all pastures as soon as the range began to turn brown. Supplementation was begun August 10 in 1961, August 8 in 1962 and August 9 in 1963.

In experiment 2, summer steer gains were 1/2 to 3/4 lb. per head daily higher in the relatively good year of 1962 than in the dry year 1961 (table 4). Heavy grazing reduced steer gains to each fall weigh date much more in the dry summer of 1961 than in 1962. This year x summer grazing treatment effect was also significant in the yearlong steer gains to each fall date.

In experiment 3 (1963) differences in summer gain to September were not significant. However, summer gains to October and November and yearlong gains to October were much lower for the steers in moderate grazing rep 1 than in rep 2. In fact, steer gains for moderate grazing rep 1 for these periods did not differ significantly from heavy grazing rep 1, whereas differences between moderate and heavy grazing in rep 2 were quite large. The different effect of grazing treatment in the two reps was probably due to range site differences in the pastures, especially the absence of draws in moderate grazing rep 1 and the large acreage of draws in heavy grazing rep 1.

During the three years of protein supplementation in late summer and fall, there was a reduction in the differences in steer gains due to site differences between pastures. However, even with protein, phosphorus and trace mineral supplementation, steer gains dropped sharply as the range cured. In 1962 steers made excellent gains on all pastures until the range began to cure in August. The condition of the steers declined rapidly during September and on September 19, the soybean oil meal was increased to 2.5 lbs. per head every other day and 50 grams of dicalcium phosphate was mixed with it. Nevertheless, even in light grazing, gains declined from an average of 2.16 lbs. per head daily in July to 1.86 in August, 1.12 in September and to -0.36 during October and early November. The decline in steer gains after curing was accentuated by the decrease of western wheatgrass and other cool season grasses which has occurred since 1959.

These data suggest that the alternatives to fall grazing on native range with steers should be carefully considered. Early sale, supplemental cool season tame pasture, harvested roughages, windrowed hay, or possibly in the future, chemically cured standing grass may be suitable alternatives.

The stocking rate used on the moderately grazed pastures appears to have resulted in a greater degree of forage utilization than desired. However, the precise measurement of utilization has been very difficult on these ranges.

## Effect of Level of Winter Supplementation on Steer Gains

Steer calves were purchased after weaning in the fall and winter grazed on native range deferred for winter use. Hay was fed only rarely when snow cover prevented the calves from getting enough forage. The winter supplements were all mixed from soybean oil meal and corn. Vitamin A and dicalcium phosphate were added to all supplements to meet the requirements for vitamin A and phosphorus. Trace mineralized salt was available except in 1959-60 when cobalt administration was one of the treatments. The steers were weighed monthly after an overnight shrink.

### Experiment 1 (1959-60)

The objectives of this experiment were:

1) to compare steer calves wintered on the range with a supplement to those wintered in drylot,

2) to compare the performance of calves receiving a cobalt bullet with those receiving none,

3) to study the effect of 2 planes of winter nutrition on summer and yearlong steer gains.

One hundred sixty grade Hereford steer calves were allotted by restricted randomization considering weight and origin to different groups for wintering and summer grazing.

A. Range-Drylot Comparison

Forty calves were grazed on the range and 80 were fed different proportions of alfalfa and prairie hay in 8 lots. Both groups were placed on an adaptation supplement for 30 days beginning November 30. This supplement contained 20% total protein, trace minerals and vitamin A. Half of each group received 300 mg. of aureomycin per head daily. The weather was good and there was no sickness in either group. The difference in winterlong average daily gains of the range calves fed antibiotic (.98 lbs.) and those fed no antibiotic (.94 lbs.) was small and not significant. After the first 30 days the calves on the range received 2 1/2 lbs. per head daily of a 40 percent protein supplement until April 27. They gained .98 lbs. per head daily during the entire winter (including the adaptation period). One lot of calves in drylot gained the same amount (0.98 lbs.) during the same period and ate 12.9 lbs. per head daily of a mixture of 70% alfalfa and 30% prairie hay fed free choice. With alfalfa hay at $25 per ton and prairie hay at $20, the drylot ration cost 15.2 cents per day per steer while the protein supplement at $80 per ton cost 10 cents per day. If the labor and fixed costs were equal, the range was worth about 5.2 cents per steer per day or about $2.60 per animal unit per month. If the labor and fixed costs were less for range grazing, then the value of the range would have been greater.

B. Cobalt Bullet Comparison

Half of the steers wintered on the range and half of those wintered in Brookings (Part C below) were given a cobalt bullet in mid-winter. Differences in rate of gain for cobalt and no cobalt groups during the winter and summer were small and not significant. Although there was a significant rep x cobalt interaction for summer gains to September 1, the differences did not appear to be biologically meaningful.

C. Plane of Winter Nutrition Study

Forty calves were trucked to Brookings after allotment and wintered on brome-alfalfa hay, free choice, with 4 lbs. per head daily of equal parts rolled oats and cracked corn and given 5 grubicide treatments from December 15 to March 19. After March 19 the grain in the ration was gradually reduced to 2 lbs. and 32 calves (4 lots which did not differ significantly in rate of gain) were trucked back to Cottonwood April 26. Grain feeding was stopped and they were grazed with the range calves until placed on the intensity of summer grazing pastures on May 13. The average daily gain while on feed in Brookings was 1.85 lbs., but the gain from allotment to summer pasture was only 1.13 lbs. per head daily. The range calves gained 0.96 lbs. per head daily, significantly less ($P < .01$) during the same period. The Brookings calves were much mellower and softer than the range calves. The range calves on all grazing rates gained slightly, but not significantly, faster than the Brookings calves during the summer. Yearlong gains from fall to November 14 were .83 lbs. per head daily for the Brookings calves and .78 lbs. for the range calves. Likewise, yearlong gains to the September and October weigh dates did not differ significantly.

Experiment 2 (1960-61 and 1961-62)

The objectives of this experiment were:

1) to compare the winter gains of steer calves fed supplements containing different levels of protein with the same level of energy,

2) to study the effect of different levels of protein in the supplement on summer and yearlong steer gains.

Each fall 54 steer calves were allotted by restricted randomization to 18 groups of 3 calves each which were assigned at random to 3 levels of protein, 3 summer grazing intensities in 2 replications. The 3 winter treatments were 2 1/2 lbs. per head daily of a supplement containing 14, 27 or 40% total protein to supply 1/3, 2/3 or 1 lb. of total protein. This supplement was fed daily until greenup (April 11 in 1961 and April 19 in 1962). The calves were grazed in 3 groups and rotated between pastures biweekly or weekly to minimize pasture differences. After experimental feeding was discontinued the cattle were run together and treated alike until placed on the summer intensity of grazing pastures. In 1961-62 snow cover made it impossible for the calves to get sufficient forage. Consequently, a partial feed of hay (average 5.5 lbs. per head daily) was given to all lots for 29 days. No hay was fed in 1960-61.

The effect of level of winter protein supplementation on the average daily gains of the calves for various periods in the two years is shown in table 7. During the period from fall to greenup, total protein in the supplement restricted the gain of the low protein group to about 1/3 lb. per head daily. Two-thirds pound of total protein was adequate to support gains of about 2/3 pound per head daily. Increasing the amount of protein in the supplement to one pound per head daily did not result in a significant increase in daily gain. At the higher protein level, the energy content of the ration apparently limited the gain. Steers fed the higher levels of protein appeared brighter, more alert and more active. However, the low protein group was thrifty and showed no real symptoms of distress.

The steers gained slightly more the first year than the second year ($P < .05$) and in the second year the 1 lb. total protein level produced slight increases in gain over the 2/3 lb. level. However, these gains were not significantly different. These data suggest that the forage produced in 1961 during a drought period (table 1) may have been lower in total protein and energy value than that produced in the relatively good year, 1960. This is also suggested by the low steer gains in 1961 (table 4).

During the period between greenup and summer pasture the steers on the low protein supplement gained significantly more than the other two groups, thus reducing the difference between treatments in rate of gain from fall to summer. Over both years the low protein supplement produced gains of .58 lbs. per head daily, significantly lower than the 3/4 pound gains of the groups fed the higher protein supplements. Weight compensation was so great in 1962 that the winterlong gain of the low protein group did not differ significantly from the two groups fed the higher protein supplement.

On summer pasture weight compensation continued to occur with the low protein group gaining about .1 to .2 lbs. more per head daily then the other groups. This difference was not significant for summer gain to September but was for summer gain to October and November. Yearlong gains to all 3 fall weigh dates in both years were very similar regardless of winter treatment.

The effect of winter treatment on summer gain or yearlong gain did not differ significantly under different intensities of summer grazing.

From these data we may conclude:

1. In these two years 2/3 pound of total protein contained in 2 1/2 pounds of concentrate feed (soybean oil meal, corn and dicalcium phosphate) was adequate to support about 2/3 lb. daily gain on steer calves grazed on native range in the winter.

2. Increasing the amount of total protein without increasing the total supplement did not result in significantly increased steer gains.

3. Steer calves wintered to gain 1/3 pound per head daily did not differ significantly in yearlong gains from calves fed to gain 2/3 to 3/4 lb., regardless of whether the terminal date was the September, October or November weigh date.

Experiment 3 (1962-63)

The objectives of this experiment were:

1) to compare the winter gains of steers fed different amounts of supplement but equal amounts of total protein,

2) to study the effect of different amounts of supplement on summer and yearlong steer gains.

Calves were purchased in November and allotted as in experiment 2 to 3 levels of winter supplementation, 3 summer grazing intensities, and 2 replications. The 3 levels of winter supplementation were 1 1/2, 2 1/2 and 3 1/2 lbs. of total supplement containing 2/3 pound of total protein. Total protein percentages in the supplement of 44, 27 and 19% for the low, intermediate and high levels of supplementation, respectively, were obtained by substituting corn for soybean oil meal. Thus, the energy concentration in each supplement was very similar. Supplementation was begun December 7. The high supplement group went on feed more slowly than the other 2 groups.

The effect of amount of winter supplementation on steer gains for various periods is shown in table 8. Although the calves fed the higher rate of supplement gained significantly more to greenup (.66 lbs. per head daily) than those fed the intermediate (.53 lbs.) or the low level (.49 lbs.), the differences were quite small and suggest that while steers respond to supplements of both protein and energy the most critical need is for protein. The kind and amount of supplement fed to the intermediate group was the same that was fed to the intermediate protein level group in 1960-61 and 1961-62. The steers on this treatment gained .53 lbs. per head daily compared with .59 lbs. in 1961-62.

From greenup to summer pasture the gains were not inversely proportional to previous gains as they were in experiment 2. Instead the calves fed the intermediate amount of supplement gained significantly more (nearly 1/2 pound per head daily) than the high or low supplement groups. Consequently, the winterlong gains of the intermediate group approached that of the high group and did not differ significantly from it.

There was no trend toward compensation on summer pasture as there was in experiment 2, but there were no significant differences in summer or yearlong steer gains due to winter treatment.

This experiment is being repeated in 1963-64. However, in this trial there was no advantage in summer or yearlong steer gains from providing more feed than 1 1/2 pounds of a 44% protein supplement. Also, it appears that in order to get winter gains of more than about 1/2 to 2/3 lbs. per head daily efficiently from steer calves on winter range, more than 2/3 pounds of total protein is needed in the supplement.

Table 1. Precipitation and Evaporation at the Cottonwood Range Field Station 1959 through 1963

| | 1959 | 1960 | 1961 | 1962 | 1963 | 5 year mean |
|---|---|---|---|---|---|---|
| Annual | 15.53 | 15.18 | 14.08 | 14.92 | 17.37 | 15.42 |
| Departure[1/] | + .40 | + .05 | - 1.05 | - .21 | + 2.24 | + .29 |
| Cool season[2/] | 8.05 | 11.25 | 6.52 | 9.60 | 10.19 | 9.12 |
| Departure | - .77 | + 2.43 | - 2.30 | + .78 | + 1.37 | + .30 |
| Warm season[3/] | 3.78 | 7.02 | 5.95 | 6.20 | 6.88 | 5.97 |
| Departure | - 2.52 | + .72 | - .35 | - .10 | + .58 | - .33 |
| Vegetation year[4/] | 11.83 | 18.27 | 12.47 | 15.80 | 17.07 | 15.09 |
| Departure | - 3.30 | + 3.14 | - 2.66 | + .67 | + 1.94 | + .06 |
| March + April | 1.46 | 2.17 | 1.49 | 1.29 | 1.92 | 1.67 |
| Departure | - 1.02 | - .31 | - .99 | - 1.19 | - .56 | - .81 |
| September + October | 3.35 | 0.56 | 2.68 | 2.02 | 2.06 | 2.13 |
| Departure | + 1.34 | - 1.45 | + .67 | + .01 | + .05 | + .12 |
| Evaporation[5/] | 60 | 53 | 54 | 50 | 55 | 54 |

1/ Current minus long-term average.
2/ Preceding September through May of current year.
3/ June, July and August of current year.
4/ Preceding September through current August.
5/ Evaporation in inches from open pan April through September.

Table 2. Effect of Grazing Treatment and Year on Stocking Rate and Gain Per Acre Cottonwood Range Field Station, 1959-60 through 1962-63

| | | Summer Grazing Intensity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Heavy | | | Moderate | | | Light | | |
| Year[1/] | Measure Rep | 1 | 2 | Mean | 1 | 2 | Mean | 1 | 2 | Mean |
| 1959-60 | Stocking rate, AUM's/acre | .68 | .62 | .65 | .37 | .39 | .38 | .32 | .32 | .32 |
| | Gain/acre, lb. | 17.6 | 6.2 | 11.9 | 7.2 | 9.1 | 8.2 | 10.3 | 13.4 | 11.8 |
| 1960-61 | Stocking rate, AUM's/acre | .63 | .56 | .59 | .34 | .35 | .34 | .25 | .27 | .26 |
| | Gain/acre, lb. | 11.1 | 5.8 | 8.3 | 11.7 | 12.9 | 12.2 | 12.8 | 13.4 | 13.1 |
| 1961-62 | Stocking rate, AUM's/acre | .56 | .49 | .52 | .31 | .34 | .33 | .25 | .25 | .25 |
| | Gain/acre, lb. | 29.0 | 24.5 | 26.6 | 16.9 | 18.9 | 19.1 | 15.9 | 13.7 | 14.8 |
| 1962-63 | Stocking rate, AUM's/acre | .59 | .36 | .48 | .28 | .30 | .29 | .22 | .22 | .22 |
| | Gain/acre, lb. | 20.2 | 15.2 | 17.5 | 10.1 | 13.4 | 11.7 | 11.5 | 12.4 | 12.0 |

1/ Protein supplement was fed in late summer and fall except in 1959-60.

Table 3. Experiment 1. Effect of Intensity of Summer Grazing on Average Daily Gains of Steers to Different Fall Dates (Across winter treatments) Cottonwood Range Field Station 1959-60[1/] [2/]

| Period | Rep | Summer Grazing Intensity Heavy | Moderate | Light | Mean |
|---|---|---|---|---|---|
| Summer, May 13 to Sept. 1 | 1 | 1.42 | 1.70 | 1.77 | 1.63[1] |
| | 2 | 1.34 | 1.64 | 1.69 | 1.55[1] |
| | Mean | 1.37[B] | 1.67[A] | 1.73[A] | 1.59 |
| Summer, May 13 to Oct. 1 | 1 | 1.22[b] | 1.18[bc] | 1.58[a] | 1.33[1] |
| | 2 | .95[c] | 1.34[b] | 1.60[a] | 1.30[1] |
| | Mean | 1.09 | 1.26 | 1.59 | 1.31 |
| Summer, May 13 to Nov. 9 | 1 | .60[bc] | .44[c] | .75[b] | .60[1] |
| | 2 | .24[d] | .54[c] | .97[a] | .58[1] |
| | Mean | .42 | .49 | .86 | .59 |
| Yearlong, Nov. 27 to Sept. 1 | 1 | 1.20 | 1.33 | 1.32 | 1.28[1] |
| | 2 | 1.14 | 1.28 | 1.29 | 1.24[1] |
| | Mean | 1.17[B] | 1.30[A] | 1.31[A] | 1.26 |
| Yearlong, Nov. 27 to Oct. 1 | 1 | 1.13[e] | 1.13[c] | 1.31[a] | 1.18[1] |
| | 2 | .99[d] | 1.17[bc] | 1.25[ab] | 1.15[1] |
| | Mean | 1.06 | 1.15 | 1.28 | 1.16 |
| Yearlong, Nov. 27 to Nov. 9 | 1 | .82[bc] | .75[c] | .89[a] | .82[1] |
| | 2 | .61[d] | .78[c] | .99[a] | .79[1] |
| | Mean | .72 | .76 | .94 | .81 |

1/ Ten steers in each grazing intensity in each rep.

2/ Values for the same period which have the same letter designation do not differ significantly at the 5% level according to Duncan's Multiple Range Test. Only those gains with the same kind of superscript, i.e. small letters, capital letters, or numbers, should be compared. Summer grazing treatments are compared by reps only if there is a significant rep x summer grazing treatment interaction.

Table 4. Experiment 2. Effect of Intensity of Summer Grazing on Average Daily Gains of Steers to Different Fall Dates in Two Years (Across winter treatments and replications) Cottonwood Range Field Station 1960-61 and 1961-62 1/

| Period | Year | Dates | Summer Grazing Intensity Heavy | Moderate | Light | Mean |
|---|---|---|---|---|---|---|
| Summer to Sept. | 60-61 | 5/16-9/1 | 1.08 | 1.27 | 1.39 | 1.25 |
| | 61-62 | 5/23-9/1 | 1.81 | 1.97 | 2.08 | 1.95 |
| | Mean | | 1.45 | 1.62 | 1.74 | 1.60 |
| Summer to Oct. | 60-61 | 5/16-10/3 | $.75^{e}$ | $1.10^{d}$ | $1.45^{c}$ | $1.10^{2}$ |
| | 61-62 | 5/23-10/2 | $1.60^{b}$ | $1.69^{b}$ | $1.84^{a}$ | $1.71^{1}$ |
| | Mean | | $1.18^{C}$ | $1.40^{B}$ | $1.65^{A}$ | 1.41 |
| Summer to Nov. | 60-61 | 5/16-11/4 | $.34^{e}$ | $.84^{d}$ | $1.16^{c}$ | $.78^{2}$ |
| | 61-62 | 5/23-11/6 | $1.20^{bc}$ | $1.28^{ab}$ | $1.38^{a}$ | $1.29^{1}$ |
| | Mean | | $.77^{C}$ | $1.06^{B}$ | $1.27^{A}$ | 1.03 |
| Fall to Sept. | 60-61 | 11/19-9/1 | .84 | .93 | .96 | $.91^{1}$ |
| | 61-62 | 11/24-9/1 | 1.07 | 1.14 | 1.18 | $1.13^{1}$ |
| | Mean | | .96 | 1.04 | 1.07 | 1.02 |
| Fall to Oct. | 60-61 | 11/19-10/3 | $.72^{e}$ | $.89^{d}$ | $1.03^{c}$ | $.88^{1}$ |
| | 61-62 | 11/24-10/2 | $1.06^{bc}$ | $1.11^{ab}$ | $1.17^{a}$ | $1.11^{2}$ |
| | Mean | | .89 | 1.00 | 1.10 | 1.00 |
| Fall to Nov. | 60-61 | 11/19-11/14 | $.51^{d}$ | $.78^{c}$ | $.94^{b}$ | $.74^{2}$ |
| | 61-62 | 11/24-11/6 | $.92^{b}$ | $.97^{ab}$ | $1.02^{a}$ | $.97^{1}$ |
| | Mean | | .72 | .88 | .98 | .86 |

1/ Eighteen steers in each grazing intensity 1960-61 and in 1961-62 except in light and moderate grazing there were 17 and in heavy grazing there were only 17 after the October weigh day.

2/ Values for the same period with the same superscript do not differ significantly at the 5% level according to Duncan's Multiple Range Test. Only those gains with the same kind of superscript, i.e. small letters, capital letters, or numbers, should be compared. Summer treatments are compared by years only if there is a significant year x summer treatment interaction. Summer treatments across years are not compared and no superscripts are used if there is a significant rep x summer treatment interaction. For these comparisons see table 5.

Table 5. Experiment 2. Effect of Intensity of Summer Grazing in Two Replications on Average Daily Gains of Steers to Different Fall Dates (Across winter treatments and years) Cottonwood Range Field Station 1960-61 and 1961-62 1/ 2/

| Period 3/ | Rep | Heavy | Moderate | Light | Mean |
|---|---|---|---|---|---|
| | | Summer Grazing Intensity | | | |
| Summer to September | 1 | $1.48^{b}$ | $1.70^{a}$ | $1.70^{a}$ | $1.63^{1}$ |
| | 2 | $1.41^{b}$ | $1.53^{b}$ | $1.77^{a}$ | $1.57^{1}$ |
| | Mean | 1.45 | 1.62 | 1.74 | 1.60 |
| Summer to October | 1 | 1.45 | 1.45 | 1.66 | $1.46^{1}$ |
| | 2 | 1.09 | 1.34 | 1.64 | $1.36^{2}$ |
| | Mean | $1.18^{C}$ | $1.40^{B}$ | $1.65^{A}$ | 1.41 |
| Summer to November | 1 | .82 | 1.03 | 1.32 | $1.06^{1}$ |
| | 2 | .71 | 1.08 | 1.23 | $1.01^{1}$ |
| | Mean | $.77^{C}$ | $1.06^{B}$ | $1.27^{A}$ | 1.03 |
| Fall to September | 1 | $1.00^{b}$ | $1.10^{a}$ | $1.04^{ab}$ | $1.00^{2}$ |
| | 2 | $.91^{c}$ | $.98^{bc}$ | $1.11^{a}$ | $1.05^{1}$ |
| | Mean | .96 | 1.04 | 1.07 | 1.02 |
| Fall to October | 1 | $.95^{b}$ | $1.05^{a}$ | $1.08^{a}$ | $1.03^{1}$ |
| | 2 | $.82^{c}$ | $.95^{b}$ | $1.12^{a}$ | $.96^{2}$ |
| | Mean | .89 | 1.00 | 1.10 | 1.00 |
| Fall to November | 1 | $.78^{c}$ | $.89^{b}$ | $.98^{a}$ | $.88^{1}$ |
| | 2 | $.66^{d}$ | $.86^{b}$ | $.98^{a}$ | $.83^{2}$ |
| | Mean | .72 | .88 | .98 | .86 |

1/ Eighteen steers in each grazing intensity in each rep except 17 each in light rep 1, moderate rep 1 and 17 in heavy rep 1 after October.

2/ Values for the same period with the same superscript do not differ significantly at the 5% level according to Duncan's Multiple Range Test. Only those gains with the same superscript, i.e. small letters, capital letters, or numbers, should be compared. Summer grazing treatments are compared by reps only if there is a significant rep x summer grazing treatment interaction.

3/ For dates see table 4.

Table 6. Experiment 3. Effect of Intensity of Summer Grazing on Average Daily Gains of Steers to Different Fall Dates (Across winter treatments) Cottonwood Range Field Station 1962-63 1/ 2/

| Period | Rep | Summer Grazing Intensity Heavy | Moderate | Light | Mean |
|---|---|---|---|---|---|
| Summer, May 21 to Sept. 4 | 1 | 1.34 | 1.44 | 1.74 | 1.51$^{1}$ |
| | 2 | 1.35 | 1.43 | 1.59 | 1.44$^{1}$ |
| | Mean | 1.35$^{A}$ | 1.43$^{A}$ | 1.67$^{A}$ | 1.48 |
| Summer, May 21 to Oct. 2 | 1 | 1.15$^{b}$ | 1.14$^{b}$ | 1.48$^{a}$ | 1.26$^{1}$ |
| | 2 | .97$^{c}$ | 1.36$^{a}$ | 1.50$^{a}$ | 1.28$^{1}$ |
| | Mean | 1.06 | 1.25 | 1.49 | 1.27 |
| Summer, May 21 to Nov. 5 | 1 | .80$^{c}$ | .85$^{c}$ | 1.20$^{a}$ | .95$^{1}$ |
| | 2 | .73$^{c}$ | 1.03$^{b}$ | 1.29$^{a}$ | 1.02$^{1}$ |
| | Mean | .76 | .94 | 1.25 | .98 |
| Yearlong Dec. 7 to Sept. 4 | 1 | 1.01 | 1.06 | 1.17 | 1.08$^{1}$ |
| | 2 | .96 | 1.01 | 1.06 | 1.01$^{2}$ |
| | Mean | .98$^{B}$ | 1.03$^{AB}$ | 1.12$^{A}$ | 1.04 |
| Yearlong Dec. 7 to Oct. 2 | 1 | .96$^{b}$ | .96$^{b}$ | 1.10$^{a}$ | 1.01$^{1}$ |
| | 2 | .82$^{c}$ | 1.02$^{ab}$ | 1.07$^{a}$ | .97$^{1}$ |
| | Mean | .89 | .99 | 1.09 | .99 |
| Yearlong Dec. 7 to Nov. 5 | 1 | .80 | .83 | 1.02 | .88$^{1}$ |
| | 2 | .71 | .89 | 1.00 | .87$^{1}$ |
| | Mean | .76$^{A}$ | .86$^{A}$ | 1.01$^{A}$ | .88 |

1/ Nine steers in each summer grazing treatment in each rep except 8 steers in heavy grazing rep 2.

2/ Values for the same period which have the same superscript do not differ significantly at the 5% level according to Duncan's Multiple Range Test. Only those gains with the same kind of superscript, i.e. small letters, capital letters, or numbers, should be compared. Summer treatments are compared between reps only if there is a significant rep x summer treatment interaction.

Table 7. Experiment 2. Effect of Level of Winter Protein Supplementation on the Average Daily Gains of Steer Calves For Different Periods in Two Years (Across summer treatments and replications) Cottonwood Range Field Station 1960-61 and 1961-62[1/] [2/]

| Period | Year | Dates | Winter Treatment: Range grazing plus 2 1/2 lbs. per head daily of a supplement containing total protein of: | | | |
|---|---|---|---|---|---|---|
| | | | 1/3 lb. | 2/3 lb. | 1 lb. | Mean |
| Fall to greenup | 60-61 | 11/19-4/11 | .30$^{c}$ | .76$^{a}$ | .74$^{a}$ | .60$^{1}$ |
| | 61-62 | 11/24-4/19 | .34$^{c}$ | .59$^{b}$ | .68$^{ab}$ | .54$^{2}$ |
| | Mean | | .32$^{B}$ | .67$^{A}$ | .71$^{A}$ | .57 |
| Greenup to summer | 60-61 | 4/12-5/16 | 1.56 | .91 | .96 | 1.14$^{1}$ |
| | 61-62 | 4/20-5/23 | 1.82 | 1.52 | .94 | 1.29$^{1}$ |
| | Mean | | 1.69$^{A}$ | 1.01$^{B}$ | .95$^{B}$ | 1.22 |
| Fall to summer | 60-61 | 11/19-5/16 | .54$^{c}$ | .79$^{a}$ | .79$^{a}$ | .71$^{1}$ |
| | 61-62 | 11/24-5/23 | .61$^{bc}$ | .68$^{b}$ | .73$^{ab}$ | .67$^{1}$ |
| | Mean | | .58$^{B}$ | .74$^{A}$ | .76$^{A}$ | .69 |
| Summer to September | 60-61 | 5/16-9/1 | 1.38 | 1.26 | 1.11 | 1.25$^{1}$ |
| | 61-62 | 5/23-9/1 | 2.00 | 1.93 | 1.92 | 1.95$^{1}$ |
| | Mean | | 1.69$^{A}$ | 1.60$^{A}$ | 1.52$^{A}$ | 1.60 |
| Summer to October | 60-61 | 5/16-10/3 | 1.23 | 1.13 | .94 | 1.10$^{1}$ |
| | 61-62 | 5/23-10/2 | 1.79 | 1.70 | 1.66 | 1.71$^{2}$ |
| | Mean | | 1.51$^{A}$ | 1.41$^{B}$ | 1.30$^{C}$ | 1.41 |
| Summer to November | 60-61 | 5/16-11/14 | .88 | .80 | .64 | .78$^{1}$ |
| | 61-62 | 5/23-11/6 | 1.34 | 1.31 | 1.21 | 1.29$^{2}$ |
| | Mean | | 1.11$^{A}$ | 1.06$^{B}$ | .93$^{C}$ | 1.03 |
| Fall to September | 60-61 | 11/19-9/1 | .86 | .97 | .91 | .91$^{1}$ |
| | 61-62 | 11/24-9/1 | 1.12 | 1.13 | 1.15 | 1.13$^{1}$ |
| | Mean | | .99$^{A}$ | 1.05$^{A}$ | 1.03$^{A}$ | 1.02 |
| Fall to October | 60-61 | 11/19-10/3 | .85 | .94 | .85 | .88$^{1}$ |
| | 61-62 | 11/24-10/2 | 1.11 | 1.11 | 1.12 | 1.11$^{2}$ |
| | Mean | | .98$^{A}$ | 1.02$^{A}$ | .99$^{A}$ | 1.00 |
| Fall to November | 60-61 | 11/19-11/14 | .72 | .80 | .71 | .74$^{1}$ |
| | 61-62 | 11/24-11/6 | .96 | .99 | .96 | .97$^{2}$ |
| | Mean | | .84$^{A}$ | .90$^{A}$ | .84$^{A}$ | .86 |

1/ Eighteen steers in each winter treatment in 1960-61 and in 1961-62 except in the 2/3 lb. total protein group there were 17 steers at all periods through October and 16 in November. After going on summer pasture there were only 17 steers in the 1/3 total protein group.

2/ Values for the same period which have the same superscript do not differ significantly at the 5% level according to Duncan's Multiple Range Test. Only those gains with the same kind of superscript, i.e. small letters, capital letters, or numbers, should be compared. Winter treatments are compared between years only if there is a significant year x winter treatment interaction.

Table 8. Experiment 3. Effect of Amount of Winter Supplementation on the Average Daily Gains of Steer Calves for Different Periods (Across summer treatments and replications) Cottonwood Range Field Station 1962-63 1/ 2/

| Period | Winter Treatment: Range grazing plus 2/3 lbs. of total protein contained in total supplement: 1 1/2 lbs. | 2 1/2 lbs. | 3 1/2 lbs. | Mean |
|---|---|---|---|---|
| Fall (Dec. 7) to greenup (April 26) | .49[b] | .53[b] | .66[a] | .56 |
| Greenup to summer pasture (May 21) | 1.81[b] | 2.28[a] | 1.82[b] | 1.97 |
| Fall to summer pasture | .67[b] | .79[a] | .83[a] | .77 |
| Summer to September 4 | 1.51[a] | 1.44[a] | 1.50[a] | 1.48 |
| Summer to October 2 3/ | 1.29 | 1.24 | 1.28 | 1.27 |
| Summer to November 5 | .98[a] | .96[a] | 1.00[a] | .99 |
| Yearlong (Dec. 7) to September 4 | 1.01[a] | 1.04[a] | 1.08[a] | 1.05 |
| Yearlong to October 2 | .95[a] | .99[a] | 1.03[a] | .99 |
| Yearlong to November 5 | .82[a] | .88[a] | .92[a] | .88 |

1/ Eighteen steers in each winter treatment except only 17 in the 1 1/2 lb. group after going on summer pasture.

2/ Values for the same period which have the same superscript do not differ significantly at the 5% level according to Duncan's Multiple Range Test.

3/ The rep x winter treatment interaction was significant at the 5% level. The means separated by Duncan's Multiple Range Test are as follows:

| Rep | 1 1/2 lbs. | 2 1/2 lbs. | 3 1/2 lbs. |
|---|---|---|---|
| 1 | 1.20[b] | 1.29[ab] | 1.30[ab] |
| 2 | 1.39[a] | 1.20[b] | 1.26[b] |

# MINERAL SUPPLEMENTS AND BACITRACIN IN WINTERING AND FINISHING RATIONS FOR CATTLE

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(This report is taken from Animal Science Department report AS 64-13)

These experiments are a continuation of a series begun a few years ago to test methods of mineral supplementation and types of mineral supplements for cattle fed various kinds of rations. Supplying the required amounts of mineral elements in cattle rations is a complex problem. Several mineral elements are required, the amounts depending on factors such as age, size, type of production and rate of production. The content of various mineral elements in feeds vary widely and the feeds may be offered in a large number of combinations and amounts.

Fortunately there is a rather wide range between the minimum needs and the toxic levels for most minerals. A common recommendation is to offer mineral supplements free-access. This recommendation is based on the assumption that the animals will consume adequate amounts, but not too much, when supplemented in this way. Experimental evidence for this recommendation is rather meager, but observations under practical conditions indicate that free-access to mineral supplements is a satisfactory method. More information is needed, however, on the importance of the kinds of mineral supplements to offer with various types of rations.

These experiments were designed to compare types of mineral supplements offered on a free access basis with wintering and finishing rations. An antibiotic, bacitracin, was used to test its value with the various rations.

## EXPERIMENT 1 - Prairie Hay Wintering Rations for Calves

### Procedure

Ninety-six Hereford steer calves were used in this experiment and allotted to the treatments shown in table 1. The calves were purchased at a nearby auction market and from a local rancher. They had been at the station from 2 to 4 days prior to being put on the experiment.

The experimental rations consisted of a full feed of prairie hay and 2 lb. of protein supplement. Four mineral supplementation treatments were used as shown in table 1. One lot of calves receiving each mineral treatment was fed bacitracin in the protein supplement.

The protein supplements contained about 40% protein. Those without added minerals were composed of 87% soybean meal (44% protein) and 13% ground shelled corn. The supplements with the added minerals were composed of 90% soybean meal, 6% trace mineral salt and 4% dicalcium phosphate. When bacitracin was used, it was added to the supplements at levels to furnish 350 mg. daily of bacitracin for the first 28 days of the experiment and then 35 mg. daily for the remainder of the 157-day experiment. A bacitracin premix replaced an equal weight of soybean meal in the protein supplements.

The calves had access to sheds with the hay being fed inside. The free-access mineral supplements were supplied in mineral boxes inside the sheds. The hay and supplements were fed once daily. All the calves were treated for the control of grubs. Initial and final weights were taken after an overnight stand without feed and water. The results are presented for the calves finishing the trial. Two losses occurred and feed consumption was adjusted by deducting an average amount of feed for the time each calf was on the experiment.

## Results

Results of the experiment are presented in table 1.

The mineral supplementation treatments did not appear to affect the performance of the cattle. Consumption of the free-access mineral supplements was low; and except in one instance, total consumption was similar for the different supplements. The low consumption in comparison to the calves force-fed the minerals in the protein supplement did not affect performance during the experiment. Apparently this low intake was adequate to supplement that contained in the hay and protein supplement for gains of about 1 lb. daily.

The gains made by the calves fed bacitracin were about the same as for those fed the protein supplements without this antibiotic. This was also true at 28 days when the 350 mg. daily level was changed to 35 mg. Several calves showed symptoms of the shipping fever complex during the first few weeks of the experiment, and bacitracin did not appear to reduce the incidence. Apparently bacitracin was not beneficial in this experiment at the levels fed.

The average feed requirement in this experiment was 1104 lb. of prairie hay and 184 lb. of protein supplement per 100 lb. of gain when the calves made an average daily gain of about 1.1 lb. Feed cost for wintering with these rations can be estimated using these feed requirements and current feed prices. The costs have been calculated and presented in table 1 for this experiment.

## EXPERIMENT 2 - Corn Grain and Corn Silage Finishing Rations

## Procedure

The Hereford steers used in this experiment were taken off native range and alfalfa-brome pastures and fed alfalfa-brome hay with a limited amount of concentrates for about 3 to 5 weeks prior to being put on the experiment. They were allotted to 6 lots of 10 each on the basis of previous type of pasture and weight. The experimental rations when on full feed consisted of 20 lb. of corn silage, 2 lb. of protein supplement and a full feed of rolled shelled corn. Three mineral treatments were used as shown in table 2.

The protein supplements contained about 38% protein. The supplements without added minerals were composed of 80% soybean meal, 19% ground shelled corn, 0.5% urea and 0.5% stilbestrol premix (5 mg./lb. suppl.). The supplements with added minerals were composed of 84% soybean meal, 6% trace mineral salt, 7.5% ground limestone, 1.5% dicalcium phosphate, 0.5% urea and 0.5% stilbestrol premix. When bacitracin was fed, a bacitracin premix was used to replace an equal weight of the soybean meal. It was added to furnish 35 mg. of bacitracin per steer daily in 2 lb. of the protein supplements.

The cattle were fed in outside lots without access to shelter. After getting on full feed, they were fed once daily in amounts so feed would be available at all times. The mineral supplements were offered in uncovered mineral boxes in the lots. When losses occurred, the feed consumption was adjusted by deducting an average amount of feed for the time each steer was on the experiment.

## Results

Results of this experiment are presented in table 2.

There were some differences in rate of gain between treatments, but the results do not indicate any consistent advantage in favor of any mineral treatment or for bacitracin. These differences in rate of gain were not statistically significant. There were also some differences between treatments in feed efficiency and carcass grades, but they were rather inconsistent as was the rate of gain.

When the mineral ingredients were included in the protein supplements, they were added at levels to furnish rations with an estimated 0.4% calcium, 0.3% phosphorus and 0.5% salt. Offering the mineral ingredients separately on a free-choice basis resulted in a lower intake of salt and limestone but a greater intake of dicalcium phosphate than when force-fed in the protein supplement. Offering the mineral mixture composed of 40% dicalcium phosphate, 40% trace mineral salt and 20% limestone resulted in a reduction in consumption of all ingredients in comparison to offering the individual ingredients separately.

Apparently these differences in mineral intake had no influence on performance of the cattle. The results do show that the type of mineral supplement offered free-access may have a large effect on the amount of minerals consumed.

## EXPERIMENT 3 - Corn Grain and Corn Silage Finishing Rations

## Procedure

Hereford steers were used in this experiment and they were taken off native range pasture in late fall. The procedures in conducting the experiment and the rations fed were the same as for Experiment 2 except for the level of corn silage fed. The cattle were started on 40 lb. of corn silage per head daily. The amount was reduced by 3 lb. per head daily to a level of 10 lb. and held constant for the remainder of the trial.

## Results

Results of the experiment are presented in table 3.

The rate of gain was about the same for the three lots fed the rations without bacitracin. Two lots fed the rations with bacitracin gained somewhat more than the steers fed similar rations without the antibiotic. These differences between mineral treatments and bacitracin were not statistically significant. However, the results obtained with bacitracin indicate that further work is needed with this antibiotic.

The rations fed in this experiment were composed of a smaller amount of corn silage and a larger amount of corn grain than in Experiment 2, and they would be expected to be lower in calcium and higher in phosphorus. Offering the mineral ingredients separately on a free-choice basis resulted in a lower intake of salt and limestone but a higher intake of dicalcium phosphate as in Experiment 2. Consumption of the limestone was considerably higher in relation to consumption of salt and dicalcium phosphate than in Experiment 2. This indicates an ability of the cattle to adjust intake of mineral supplements with rations varying in concentration of the minerals.

Lower total mineral consumption occurred when the mineral mixture was offered with the reduction being greatest for limestone because of the lower content of this ingredient in the mixture. This reduction in mineral consumption from the mineral mixture also occurred in the previous experiment. However, the differences in consumption encountered here did not appear to be great enough to affect the performance of the cattle.

## SUMMARY

A wintering trial with calves full-fed prairie hay and two finishing trials with steers fed corn silage and corn grain rations have shown that the type of ration and the type of mineral supplement offered free-access affect the amount of mineral elements consumed. Differences in amounts of salt, dicalcium phosphate and ground limestone consumed in these experiments did not affect the performance of the cattle. It appears that free-access to mineral supplements is a satisfactory way to furnish the mineral needs of cattle. However, more work is needed on the effects of rations and waters having high mineral contents and of mineral supplements which may tend to unbalance rather than balance the mineral content of the feeds and water.

Performance of cattle did not appear to be improved when bacitracin was fed in a wintering ration at 350 mg. daily for 28 days and then at 35 mg. for the remainder of a 157-day experiment. Feeding bacitracin at 35 mg. daily in finishing rations did not significantly improve performance of the cattle in two experiments. However, results obtained with bacitracin in one experiment indicate further work is needed with this antibiotic.

Table 1. Mineral Supplements and Bacitracin for Wintering Calves
(Cottonwood - November 17 to April 23, 1963 - 157 days)

| | Force-fed[a] | | Free choice[b] ingredients | | Free choice[c] mix | | Free choice[d] mix | |
|---|---|---|---|---|---|---|---|---|
| | Control | Bacitracin | Control | Bacitracin | Control | Bacitracin | Control | Bacitracin |
| Number steers | 11[e] | 12 | 12 | 12 | 12 | 12 | 12 | 11[f] |
| Init. shrunk wt., lb. | 364 | 364 | 364 | 366 | 365 | 362 | 370 | 365 |
| Final shrunk wt., lb. | 542 | 540 | 536 | 524 | 547 | 532 | 540 | 539 |
| Av. daily gain, lb. | 1.13 | 1.12 | 1.09 | 1.00 | 1.16 | 1.08 | 1.08 | 1.10 |
| Av. daily ration, lb. | | | | | | | | |
| Prairie hay | 12.3 | 12.4 | 12.3 | 11.3 | 12.1 | 12.2 | 12.1 | 12.1 |
| Protein suppl. | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Av. daily minerals consumed, gm. | | | | | | | | |
| T.M. salt | 54.0 | 54.0 | 8.7 | 7.6 | 2.0 | 5.6 | 6.5 | 8.2 |
| Dical. phos. | 36.0 | 36.0 | 2.2 | 5.0 | 2.0 | 5.6 | 2.4 | 3.3 |
| Limestone | -- | -- | 2.4 | 0.9 | -- | -- | -- | -- |
| Feed per 100 lb. gain, lb. | | | | | | | | |
| Prairie hay | 1090 | 1112 | 1126 | 1126 | 1042 | 1125 | 1119 | 1095 |
| Protein suppl. | 178 | 180 | 185 | 201 | 173 | 186 | 186 | 182 |
| Feed cost per 100 lb. gain, $[g] | 19.06 | 19.37 | 19.17 | 19.84 | 17.81 | 19.23 | 19.16 | 18.77 |
| Feed cost per head, $ | 33.82 | 34.02 | 32.81 | 31.27 | 32.50 | 32.68 | 32.50 | 32.53 |
| Init. cost @ $34/cwt., $ | 123.90 | 123.86 | 123.93 | 124.58 | 124.10 | 123.05 | 125.90 | 124.27 |
| Init. and feed cost per head, $ | 157.72 | 157.88 | 156.74 | 155.85 | 156.60 | 155.73 | 158.40 | 156.80 |
| Init. and feed cost per 100 lb. final wt., $ | 29.11 | 29.24 | 29.26 | 29.74 | 28.60 | 29.28 | 29.33 | 29.11 |

[a]Dicalcium phosphate, ground limestone and trace mineral salt added to the protein supplement to give an estimated 0.3% phosphorus, 0.4% calcium and 0.5% salt in the total ration.
[b]Dicalcium phosphate, ground limestone and trace mineral salt offered separately on a free-choice basis.
[c]Free-access mixture of equal parts dicalcium phosphate and trace mineral salt.
[d]Free-access mixture of 75% dicalcium phosphate and 25% trace mineral salt with additional trace mineral salt free access.
[e]One chronic bloater removed from the lot.
[f]One death from pneumonia.
[g]Feed prices used per ton: Prairie hay, $20; protein supplement (exclusive of minerals), $85; trace mineral salt, $45; dicalcium phosphate, $100 and ground limestone, $20. Cost of bacitracin not included.

Table 2. Mineral Supplements and Bacitracin for Finishing Cattle
(Oct. 3 to Feb. 26, 1963 - 145 days)

| | Force-fed[a] | | Free-access ingredients[b] | | Free-access mix[c] | |
|---|---|---|---|---|---|---|
| | Control | Bacitracin | Control | Bacitracin | Control | Bacitracin |
| Number steers | 9[d] | 8[e] | 10 | 10 | 10 | 10 |
| Init. shrunk wt., lb. | 769 | 750 | 757 | 759 | 755 | 755 |
| Final shrunk wt., lb. | 1184 | 1152 | 1198 | 1175 | 1163 | 1190 |
| Av. daily gain, lb. | 2.87 | 2.77 | 3.04 | 2.87 | 2.81 | 3.00 |
| Av. daily ration, lb. | | | | | | |
| Corn silage | 19.8 | 19.5 | 19.2 | 19.2 | 19.3 | 19.3 |
| R. sh. corn | 16.3 | 15.5 | 15.9 | 16.0 | 16.3 | 16.3 |
| Prot. suppl. | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Av. daily minerals consumed, gm. | | | | | | |
| T.M. salt | 54 | 54 | 21 | 16 | 10 | 12 |
| Dical. phos. | 14 | 14 | 26 | 24 | 10 | 12 |
| Limestone | 68 | 68 | 11 | 9 | 5 | 6 |
| Feed per 100 lb. gain, lb. | | | | | | |
| Corn silage | 690 | 696 | 629 | 667 | 686 | 642 |
| R. sh. corn | 569 | 553 | 524 | 558 | 579 | 543 |
| Prot. suppl. | 69 | 71 | 65 | 69 | 71 | 66 |
| Feed cost per 100 lb. gain, $[f] | 17.24 | 17.03 | 15.92 | 16.93 | 17.51 | 16.40 |
| Feed cost per head, $ | 71.55 | 68.46 | 70.21 | 70.43 | 71.44 | 71.34 |
| Dressing percent | 60.3 | 59.8 | 60.2 | 60.2 | 60.1 | 59.3 |
| Carcass grade[g] | 18.7 | 18.7 | 19.3 | 19.3 | 18.8 | 18.5 |
| Marbling score[h] | 5.2 | 5.5 | 5.6 | 5.8 | 4.9 | 4.8 |
| Selling price/cwt., $[i] | 22.72 | 22.48 | 22.78 | 22.86 | 22.56 | 22.16 |
| Selling price per head, $ | 269.00 | 258.97 | 272.90 | 268.60 | 262.37 | 263.70 |

[a] Dicalcium phosphate, ground limestone and trace mineral salt added to the protein supplement to give an estimated 0.3% phosphorus, 0.4% calcium and 0.5% salt in the total ration.
[b] Dicalcium phosphate, ground limestone and trace mineral salt offered separately on a free-choice basis.
[c] Mixture composed of 40% trace mineral salt, 40% dicalcium phosphate and 20% ground limestone offered free-access.
[d] One death from a general toxemia.
[e] One loss from urinary calculi and one from a broken leg.
[f] Feed prices per ton: Corn silage, $8; rolled shelled corn, $40; protein supplement, $90.
[g] Carcass grades: Choice, 20; Good, 17.
[h] Marbling score: Moderate, 7; Modest, 6; Small, 5; Slight, 4.
[i] Based on carcass prices of $38 for Choice and $37 for Good.

Table 3. Mineral Supplements and Bacitracin for Finishing Cattle (Dec. 21 to May 14, 1963 - 144 days)

| | Force-fed[a] | | Free-access ingredients | | Free-access mix | |
|---|---|---|---|---|---|---|
| | Control | Bacitracin | Control | Bacitracin | Control | Bacitracin |
| Number steers | 10 | 10 | 10 | 10 | 10 | 10 |
| Init. shrunk wt., lb. | 739 | 734 | 737 | 740 | 747 | 738 |
| Final shrunk wt., lb. | 1124 | 1145 | 1112 | 1122 | 1133 | 1149 |
| Av. daily gain, lb. | 2.68 | 2.86 | 2.60 | 2.65 | 2.68 | 2.85 |
| Av. daily ration, lb. | | | | | | |
| Corn silage | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| R. sh. corn | 17.7 | 18.2 | 17.8 | 18.1 | 18.3 | 19.0 |
| Prot. suppl. | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Av. daily minerals consumed, gm. | | | | | | |
| T.M. salt | 54 | 54 | 24 | 23 | 21 | 24 |
| Dical. phos. | 14 | 14 | 34 | 29 | 21 | 24 |
| Limestone | 68 | 68 | 33 | 35 | 11 | 12 |
| Feed per 100 lb. gain, lb. | | | | | | |
| Corn silage | 413 | 386 | 424 | 416 | 412 | 387 |
| R. sh. corn | 662 | 634 | 683 | 682 | 679 | 666 |
| Prot. suppl. | 74 | 69 | 76 | 74 | 74 | 69 |
| Feed cost per 100 lb. gain, $[b] | 18.22 | 17.32 | 18.78 | 18.63 | 18.56 | 17.97 |
| Feed cost per steer, $ | 70.15 | 71.19 | 70.42 | 71.17 | 71.64 | 73.86 |
| Dressing percent | 61.7 | 61.9 | 61.5 | 61.6 | 61.8 | 61.3 |
| Carcass grade[c] | 18.6 | 19.6 | 18.6 | 18.0 | 18.4 | 20.2 |
| Marbling score[c] | 5.8 | 6.1 | 5.7 | 5.4 | 5.5 | 6.4 |
| Selling price per cwt., $[d] | 21.09 | 21.34 | 20.91 | 20.80 | 21.03 | 21.22 |
| Selling price per steer, $ | 237.05 | 244.34 | 232.52 | 233.38 | 238.27 | 243.82 |

[a]Mineral supplements same as for Experiment 2.
[b]Feed prices same as for Experiment 2.
[c]Carcass grade and marbling scores same as for Experiment 2.
[d]Based on carcass prices of $34.75 for Choice and $33.50 for Good.

# EFFECTS OF MINERAL CONTENT OF RATIONS ON FREE-CHOICE CONSUMPTION OF MINERAL SUPPLEMENTS AND PERFORMANCE OF CALVES

L. B. Embry, G. F. Gastler and J. E. Nesvold
(This report is taken from Animal Science Department report A.S. 65-2)

In past experiments to study methods of mineral supplementation and types of mineral supplements for cattle, comparisons were made between forced feeding and free-choice feeding. Studies were also made on the effect of types of free-choice supplements on the consumption of various mineral elements. In general, the results have indicated that free-choice feeding is a satisfactory method, but that the type of supplement should be appropriate for the rations fed.

Feedstuffs and water vary widely in mineral content. In some instances, certain mineral elements may be consumed in excess of requirements because of the concentration occurring naturally in the feed and water. Others may be deficient in the ration and supplementary sources needed. Therefore, the kinds and amounts of mineral elements added to the ration or included in a free-choice supplement will vary depending on the mineral contents of the feeds and water being offered. Thus, proper mineral supplementation becomes a complex problem.

It is commonly assumed that livestock are able to balance their mineral needs by proper selection of appropriate free-choice supplements, but this assumption has not been adequately tested under a variety of conditions. Therefore, this experiment was conducted to study the effects of the mineral content of the ration on consumption of certain mineral ingredients when cattle were allowed free-choice selection. The rations were varied in mineral content by the addition of dicalcium phosphate, limestone, and trace mineral salt. The cattle were then allowed to select any of these ingredients on a free-choice basis.

## Experimental Procedure

Ninety-six Hereford steer calves were used in this experiment. They were full-fed prairie hay and 2 lb. of a 40% protein supplement for 3 to 4 weeks prior to the beginning of the experiment. They received 20,000 I.U. of vitamin A and 350 mg. of aureomycin during the preliminary period.

The calves were allotted on basis of weight into 8 lots of 12 each for the experiment. The experimental rations consisted of a full feed of prairie hay and 2 lb. of a 40% protein supplement. A late-cut prairie hay was used in order to have a ration low in phosphorus. Urea was used in the protein supplement as a further means of reducing the mineral content of the control ration.

The ingredient composition of the control protein supplement in percent was as follows: soybean meal, 59%; ground shelled corn, 37%; and urea, 4%. Aureomycin and vitamin A were added to furnish 35 mg. and 5,000 I.U. per pound, respectively, in the protein supplement. Mineral ingredients were added at levels of 6% of the protein supplements with the corn and soybean meal being adjusted to maintain the protein content at about 40%. Four replicated treatments obtained in this way were as follows:

1. Control protein supplement
2. Dicalcium phosphate added to protein supplement
3. Limestone added to protein supplement
4. Trace mineral salt added to protein supplement

Dicalcium phosphate, ground limestone and trace mineral salt were offered separately on a free-choice basis. Protein, calcium and phosphorus contents of the feeds are presented in table 1.

The cattle had access to a shed with outside exercise lots. They were fed once daily with the hay being fed inside the shed and the protein supplements in feed bunks in the outside lots. The free-choice mineral ingredients were offered inside the shed.

Water from a well was provided in electrically heated automatic waterers. The mineral content of the water in percent was as follows: calcium, 0.004; magnesium, 0.0019; sodium, 0.026; potassium, 0.0011; sulfate ($SO_4$), 0.03; and chlorine, 0.0015. The total salt content was about 0.15% with a hardness of 10.5 grains per gallon.

## Results of the Experiment

Results of the feedlot performance are presented in table 2. Rate of gain and feed consumption were about the same for all treatments. The rations contained about 10.5% total protein and the gains were similar to those obtained in past experiments when calves were full-fed prairie hay supplemented to contain about this level of protein. Adding the mineral ingredients to the rations did not appear to affect the performance when the calves had free access to dicalcium phosphate, limestone and trace mineral salt.

Consumption of the mineral ingredients from the protein supplements and free-choice and total calcium and phosphorus intakes are shown in table 3. Including the mineral ingredients in the protein supplements resulted in an intake of only slightly less than 2 oz. per head daily. Only the trace mineral salt was consumed in any appreciable amount when offered free-choice.

Current recommended requirement for calcium for wintering calves for gains of about 1 lb. daily is 13 gm. per head daily. The amount of hay consumed with 0.37% calcium furnished nearly twice this amount. There was no apparent need for additional calcium beyond that contained in the feed and protein supplements. Free-choice consumption of the dicalcium phosphate and limestone was low. Feeding of these ingredients in the protein supplement to increase the calcium intake to nearly 3 or 4 times the above recommended requirement did not affect rate of gain, feed consumption and free-choice intake of salt.

The recommended phosphorus requirement for wintering calves for gains of about 1 lb. daily is 10 gm. per head daily. The late-cut prairie hay with only 0.13% phosphorus did not supply this much. However, that supplied by the hay and the protein supplement exceeded this recommended requirement by a slight amount. Only a small amount of phosphorus was consumed from the free-choice dicalcium phosphate. It would appear that the phosphorus levels of the rations without added dicalcium phosphate were adequate for wintering calves since rate of gain was not improved by forced feeding dicalcium phosphate which resulted in about doubling of the phosphorus intake.

Free-choice consumption of trace mineral salt amounted to about 20 gm. (about 3/4 oz.) per head daily when salt was not added to the rations. There was only a slight reduction when salt was added to the protein supplement at a level to give a daily intake of 54 gm. (about 2 oz.). Information on the minimum salt requirement for cattle is rather limited; however, 1 oz. (about 28 gm.) is generally considered an ample amount for wintering calves. The free-choice intake of about 3/4 of this amount in this experiment appeared adequate since rate of gain was not improved by feeding larger amounts through the protein supplement.

Previous experiments where various salts were added to the water for cattle would indicate that the water offered in this experiment was quite satisfactory. Total salts of various mixtures in excess of the level in the water in this experiment did not affect performance of the cattle, water consumption or free-choice consumption of mineral supplements. It would appear unlikely that the water affected the free-choice consumption of the mineral ingredients in the experiment since the amount of various elements from the water would be small in relation to that consumed from the ration and the mineral supplements.

## Summary

A ration composed of a full feed of late-cut prairie hay and 2 lb. of a 40% protein supplement without added minerals contained enough calcium and phosphorus to meet recommended requirements for wintering calves. Only small amounts of dicalcium phosphate and limestone were consumed when offered free-choice. Feeding additional calcium and phosphorus in the protein supplement did not improve performance of the calves.

Approximately 3/4 oz. of trace mineral salt was consumed per head daily when offered free-choice. The calcium and phosphorus content of the ration did not affect free-choice consumption of salt. Feeding about 2 oz. of salt in the protein supplement resulted in only a small reduction in consumption of free-choice salt and no effect on performance of the calves.

The low free-choice consumption of the dicalcium phosphate and limestone might be interpreted to mean that cattle have the ability to refuse mineral ingredients not needed when allowed to do so. On the other hand, the failure of forced feeding of salt in excess of requirements to have much effect on free-choice consumption of salt would not indicate a close relationship between free-choice consumption and the requirements. This observation and the low consumption of dicalcium phosphate, when the rations only slightly exceeded the recommended requirements for phosphorus, may indicate that factors other than the mineral content of the ration have an important influence on consumption of mineral supplements. Further studies are needed.

High roughage rations for wintering calves will generally be adequate in calcium. Since those low in phosphorus are also generally low in protein, the phosphorus requirement may be met when the ration is properly supplemented with protein. Most high protein ingredients are good sources of phosphorus. In this experiment the hay and protein supplement furnished phosphorus slightly in excess of recommended requirements even though a low phosphorus hay was selected and urea was used in the protein supplement to reduce the mineral content.

Table 1. Composition of Feeds
(10% Moisture basis)

| Feedstuff | Protein % | Calcium % | Phosphorus % | Carotene mg./lb. |
|---|---|---|---|---|
| Prairie hay | 5.88 | .37 | .13 | 2.67 |
| Protein supplements | | | | |
| Control | 40.43 | .21 | .52 | |
| Dicalcium phosphate[a] | 38.85 | 1.42 | 1.52 | |
| Limestone[a] | 38.60 | 2.50 | .51 | |
| Trace mineral salt[a] | 38.94 | .25 | .52 | |
| Dicalcium phosphate[b] | | 22.0 | 18.5 | |
| Limestone[b] | | 38.0 | | |

[a] Added at 6% of protein supplement.
[b] Guaranteed minimum analysis.

Table 2. Feedlot Performance
(November 22 to June 4, 1964 - 195 days)

| Type of supplement | Control | Dicalcium phosphate | Lime-stone | Trace mineral salt |
|---|---|---|---|---|
| Number steers | 24 | 24 | 23[a] | 24 |
| Av. init. shrunk wt., lb. | 396 | 396 | 395 | 400 |
| Av. final shrunk wt., lb. | 609 | 608 | 612 | 612 |
| Av. daily gain, lb. | 1.09 | 1.08 | 1.11 | 1.08 |
| Av. daily ration, lb: | | | | |
| Prairie hay | 12.5 | 12.5 | 12.6 | 12.6 |
| Protein supplement | 2.0 | 2.0 | 2.0 | 2.0 |
| Feed per 100 lb. gain, lb. | | | | |
| Prairie hay | 1150 | 1156 | 1135 | 1168 |
| Protein supplement | 183 | 185 | 180 | 184 |

[a] One steer with urinary calculi removed from the experiment.

Table 3. Mineral Consumption
(Gm./head daily)

| Type of supplement | Control | Dicalcium phosphate | Limestone | Trace mineral salt |
|---|---|---|---|---|
| Dicalcium phosphate | | | | |
| Protein supplement | | 54.5 | | |
| Free-choice mineral | 1.5 | 2.6 | 5.4 | 4.2 |
| Limestone | | | | |
| Protein supplement | | | 54.5 | |
| Free-choice mineral | 3.6 | 3.7 | 1.5 | 2.7 |
| Trace mineral salt | | | | |
| Protein supplement | | | | 54.5 |
| Free-choice mineral | 19.5 | 20.3 | 21.6 | 16.4 |
| Calcium | | | | |
| Hay | 21.0 | 21.0 | 21.2 | 21.2 |
| Protein supplement | 1.9 | 12.9 | 22.7 | 2.3 |
| Free-choice mineral | 1.7 | 2.0 | 1.8 | 1.9 |
| Total | 24.6 | 35.9 | 45.7 | 25.4 |
| Phosphorus | | | | |
| Hay | 7.4 | 7.4 | 7.4 | 7.4 |
| Protein supplement | 4.7 | 13.8 | 4.6 | 4.7 |
| Free-choice mineral | .3 | .5 | 1.0 | .8 |
| Total | 12.4 | 21.7 | 13.0 | 12.9 |

# PROGRESS REPORT ON PROJECT 167 AT COTTONWOOD RANGE FIELD STATION

C. A. Dinkel

There are two phases of project 167 carried on at the Cottonwood Station, both of which are related to the work at the Antelope Range Station. Facilities at the station are used for wintering the heifers produced in both the Antelope and Cottonwood cow herds. The heifer calves from the Antelope Station along with the heifer calves produced at the Cottonwood Station are wintered to gain approximately 1 pound per day and are weighed and scored 196 days after weaning. The heifers are summered on the range at Fort Meade. Replacements for both herds are selected five months after the spring weight with selections being based primarily on the 18-month weight and conformation score. The highest indexing heifers among those produced at the Antelope Station are returned to this station for replacements in the inbred lines. The next highest indexing heifers from the inbred lines and the non-inbred control line are returned to Cottonwood where they enter the second phase of project 167, the evaluation of single cross or hybrid beef cattle.

Approximately 60 cows are carried in the single cross phase of the study. The cows are mated in such a way as to produce inbred calves, single cross (a cross of two different inbred lines), topcross (inbred bull mated to control line heifers) and control line calves (control line bulls on control line heifers). The comparison of single cross performance with inbred line performance is the traditional measure of hybrid vigor. The control line was originally formed using the same animals which produced the inbred lines, only matings made in the control line were among unrelated individuals. This line allows an estimation of what could have been done through selection during the same length of time without the inbreeding carried on in the inbred lines. Thus, a comparison of the control and single cross gives a measure of the improvement we might expect in commercial production through the formation of inbred lines and the resulting single crosses. The topcross calves in comparison with the control line calves allow an estimate of the value of the inbred bulls used on out-bred or unrelated heifers as opposed to non-inbred bulls so used. In addition these data allow comparison of the inbred and control calves. However, this same comparison is available in the Antelope Range herd with far greater numbers.

Table 1 presents a five year summary of the data collected through weaning in this phase of the project. Since cows are only kept for two opportunities to calve, this means only approximately 40 cows calving each year. The numbers accumulating in the five-year period are quite small, especially considering that there were only 12 calves born in the first year. There are a total of 130 calves represented with only 30 of these, 17 and 13 respectively, appearing in the inbred and control categories. The inbred calves averaged 17 pounds lighter at weaning than did the control line calves, and this difference is not great considering that the inbred calves are from inbred mothers and no correction has been made for the fact that inbreeding depresses the milking ability of the cow. It should be pointed out also that all of these calves are from first and second calf heifers.

Comparision of the inbred and single cross calves indicates a 15 pound difference where both sets of calves are out of inbred mothers. If these data had been corrected for inbreeding of dam, the single cross calves would actually rank better than the control line calves. This increased ability to grow will be apparent in later growth data to be presented. For all practical purposes the topcross, control, and single cross calves were equal in weight at weaning. Differences in inbreeding of the calf have been adjusted, but in the practical situation inbreeding of the cow would be one of the factors involved in comparing production of single cross versus either topcross or control cattle. Conformation score at weaning did not differ greatly among the groups.

The numbers available are quite small to estimate calving percentages for the different groups with any precision since these percentage traits are affected by so many environmental situations. Theoretically we would expect the dams of the inbred and single cross calves to be less efficient reproducers because they are inbred, and the dams of the topcross and control calves more efficient in reproduction because they are not inbred. So far as these data are accurate indicators, it appears that the inbred dams of the inbred calves were poorest in reproduction. However, the mating of the unrelated bull to the inbred dams of the single cross calves brought this group up even with the control line dams, and the mating of the inbred bulls with unrelated non-inbred heifers to form the topcross calves resulted in the best reproductive performance. The same rank was maintained for percent weaned except that more calves were lost among the single cross calves, and they fell below the control for this trait. The importance of the unrelated inbred bull effect on percent born and weaned will be of particular interest as the amount of data increase.

There are fewer animals available at the yearling ages particularly in the inbred and control groups. This means that the differences are less accurately estimated. It does appear, however, that there is some compensation at least in the case of the single cross calves for the poorer environment provided by the inbred mother. The rate of gain as shown for the bulls and steers appears to indicate this. While these results are based on too few numbers to be conclusive, the comparison of the single cross and inbred calves would indicate that hybrid vigor is present for the growth traits but that the use of the inbred cow in the production of weaning calves prevents the hybrid vigor from appearing until the yearling age. However, these data indicate that the topcross group may be as productive as the single crosses and this raises a doubt as to the presence of true hybrid vigor. The advantage is there but it may be due to other than hybrid vigor as usually defined. The topcross would not have the disadvantage of utilizing inbred mothers and, therefore, may be a more practical way to utilize inbreeding. It is interesting to note that the yearling weights for the steers indicate more advantage to the single cross over the topcross. These steers were on a higher level of concentrate feeding as compared to the bulls and heifers and this may contribute to this difference.

Further data will be required to establish these findings more accurately due to large year to year variations. The groups are represented by different numbers of animals in different years and some of the groups are represented by only one or two animals in some cells of the table. The effects of these factors have not been removed for this summary. Thus, these data serve very little more than to indicate what use can be made of the data being collected.

Table 1. Over-all Summary - 1960-1964*

| | Topcross | Inbred | Control | Single Cross |
|---|---|---|---|---|
| Adj. weaning weight | 378 (45) | 358 (17) | 375 (13) | 373 (55) |
| Conformation score | High Good | Low Good | High Good | Good |
| % born of cows bred | 96 | 79 | 87 | 87 |
| % weaned of cows bred | 89 | 72 | 87 | 80 |
| Yearling weight[a] | | | | |
| Heifers | 694 (12) | 684 (6) | 642 (2) | 691 (13) |
| Bulls | 982 (11) | 865 (1) | 841 (3) | 964 (22) |
| Steers | 913 (7) | 868 (3) | 890 (2) | 955 (6) |
| Daily Gain | | | | |
| Bulls | 1.88 (11) | 1.72 (1) | 1.47 (3) | 1.92 (22) |
| Steers | 2.54 (7) | 2.46 (3) | 2.44 (2) | 2.69 (6) |
| Final conformation | High Good | Low Good | Good | High Good |

* Number of animals in the average indicated in parentheses.
[a] Adjusted for differences in age.

## CATTLE GRUB CONTROL

The work on cattle grub control at Cottonwood parallels that done at the Antelope Range Station and at Reeds Ranch. This work is reported in the section in this circular for Antelope Range. (See page 7.)

# EGG-LAYING TRIALS

## Newell and Cottonwood

W. C. Morgan

For the past eight years, pullets from the South Dakota Agricultural Experiment Station at Brookings have been performance tested at Newell. Each year 400 pullets were transported by truck and divided equally into the five pens in the laying house. Each pen of pullets was from parents which differed, depending upon the breeding system being studied at Brookings.

At Cottonwood, performance of different genetic groups has also been tested; the smaller house will accomodate four groups of 60 pullets each. Records kept at the stations included eggs laid, feed consumed, deaths, egg size and broody periods. An attempt has been made to learn how to produce improved pullets by studying different breeding methods. At each station, records were kept for an eleven-month period. The pullets for Newell were one month younger than those at Cottonwood. Age differences were necessitated by limited rearing facilities at Brookings. Newell records were kept from November 1 to September 30; those at Cottonwood were kept from October 1 to August 31.

Methods for developing useful inbred lines by different selection systems have been studied at Brookings. Most of the groups of pullets which were sent to the substations had one or both parents which were inbred White Leghorns. Last year, the results at Cottonwood indicated that selection of the inbreds on the basis of rate of production provided better parents than did a system of inbreeding without selection. Twelve different inbred lines of White Leghorns have been developed at Brookings. Pullets produced by sires from two of the selected lines laid an average of four dozen more eggs than did the pullets which were sired by males from an unselected inbred line at Cottonwood. At Newell it was observed that by using a heavier breed (Barred Rock) as one parent, egg-size was improved. The use of a heavy-breed parent did, however, increase the incidence of broodiness. Results at both stations indicated the broodiness was also influenced by inbreeding when the pullets were not pure Leghorns. At Newell, Barred Rock cocks and White Leghorn hens were used as parents for three of the experimental groups. When neither parent was inbred, there were 26 broody periods, with one inbred parent there were 141 periods and with both parents inbred there were 280 periods.

Although no major differences have been observed when the same genetic groups have been tested at the two stations, the Cottonwood pullets have laid slightly larger eggs. Larger egg size has been associated with older age at sexual maturity. The later hatched pullets at Newell normally reached sexual maturity at a younger age than did the Cottonwood pullets.

For each of the experimental groups, feed efficiency (the number of pounds of feed required to produce a dozen eggs) was determined. The two most important factors which influenced feed efficiency were total number of eggs laid and adult body size. In a typical situation, hens averaging 5.1 pounds required 5.0 pounds of feed to produce a dozen eggs, and another group of hens laying at approximately the same rate, weighing only 4.3 pounds required 4.5 pounds of feed to produce a dozen eggs.

## 1964 CROP PERFORMANCE TESTING

Joseph J. Bonnemann, Assistant Agronomist

Two performance trial programs were conducted at the Range Field Station during the 1964 crop year. The first of the trials were those including the small grains: spring wheat, oats and barley. The results of the trials plus the 1963-64 averages given in the following tables are from Experiment Station Circular 165, "1964 Small Grain Variety Trials." The plots were seeded April 15 and harvested July 24, 1964.

The second performance trial, conducted as such since 1962 by the Crop Performance Testing Activity, is the grain sorghum trial. Bird damage has been a major problem at this location. The results given are from Experiment Station Circular 167 "1964 Grain Sorghum Performance Trials." The material was seeded May 26 and harvested September 29, 1964.

TEMPERATURE AND PRECIPITATION DATE FOR 1964 SMALL GRAIN GROWING SEASON
Cottonwood, South Dakota

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cottonwood[a/] | April | 47.4 | 1.1 | | 3.59 | 1.94 | |
| | May | 60.6 | 3.2 | | 2.55 | -0.16 | |
| | June | 65.1 | -2.0 | | 5.31 | 2.33 | |
| | July | 77.2 | 1.2 | .9 | 0.87 | -0.67 | 3.44 |
| Last freeze May 24 - 32° | | | | | 12.32 | | |

STANDARD VARIETY SPRING WHEAT TRIALS, RANGE FIELD STATION, COTTONWOOD, 1963-1964

| Variety | 1963 | 1964 | 1963-64 | 1964 Test Wt. lb/bu |
|---|---|---|---|---|
| | Average Yields, bushels per acre | | | |
| CI 13654 | 17.5 | 28.1 | 22.8 | 60.0 |
| CI 13655 | | 28.1 | | 61.5 |
| Justin | 14.8 | 28.1 | 21.5 | 57.5 |
| Rushmore | 18.6 | 27.9 | 23.3 | 60.0 |
| CI 13751 | 17.2 | 27.3 | 22.3 | 59.5 |
| CI 13586 | 13.5 | 25.9 | 19.7 | 59.5 |
| Canthatch | 16.6 | 24.9 | 20.8 | 58.5 |
| Selkirk | 15.4 | 24.0 | 19.7 | 55.5 |
| Crim | 13.6 | 23.1 | 18.4 | 58.5 |
| Thatcher | 15.5 | 23.0 | 19.3 | 58.0 |
| Mida | 14.0 | 23.0 | 18.5 | 59.5 |
| Pembina | 14.8 | 22.4 | 18.6 | 57.0 |
| Ceres | | 21.6 | | 58.5 |
| Lee | 11.8 | 20.6 | 16.2 | 57.5 |
| Marquis | 10.9 | 13.2 | 12.1 | 49.0 |
| | Mean yield | 24.1 | | |
| LSD .05 | N.S. | N.S. | 1964: | Date Planted - April 15<br>Date Harvested - July 24 |

STANDARD VARIETY OAT TRIALS

1960-1964
Cottonwood

| Variety | 1963 | 1964 | 1963-64 | 1964 Test Wt. lb/bu | Statistical Significance |
|---|---|---|---|---|---|
| | Average Yields, bu/A | | | | |
| CI 7679 | | 46.9 | | 37.0 | |
| Brave | | 43.0 | | 38.0 | |
| Garland | 31.8 | 42.0 | 36.9 | 39.0 | |
| Andrew | 29.2 | 41.0 | 35.1 | 37.5 | |
| CI 7463 | | 40.1 | | 39.0 | |
| Tippecanoe | | 39.2 | | 38.0 | |
| CI 7454 | | 38.6 | | 37.5 | |
| Dupree | 37.6 | 38.5 | 38.0 | 37.0 | |
| Burnett | 33.3 | 38.4 | 35.9 | 38.5 | |
| Mo. 0-205 | 29.4 | 38.1 | 33.8 | 35.5 | |
| CI 7978 | | 36.4 | | 36.0 | |
| Dodge | 29.0 | 36.1 | 32.6 | 39.0 | |
| Newton | | 36.1 | | 38.5 | |
| Neal | 27.8 | 35.3 | 31.6 | 37.0 | |
| Nehawka | 28.4 | 34.6 | 31.5 | 38.0 | |
| Minhafer | 28.5 | 34.5 | 31.5 | 38.5 | |
| Coachman | 32.5 | 34.2 | 33.3 | 37.0 | |
| Portage | 32.0 | 33.6 | 32.8 | 38.0 | |
| Ortley | 30.4 | 32.1 | 31.3 | 38.0 | |
| Brunker | 31.1 | 30.8 | 31.0 | 38.0 | |
| Clintland 64 | | 29.8 | | 38.0 | |
| Bonkee | 25.3 | 28.3 | 26.8 | 40.0 | |
| Putnam 61 | | 27.9 | | 38.0 | |
| Nodaway | | 27.0 | | 38.5 | |
| Clintland 60 | 28.9 | 26.4 | 27.7 | 40.0 | |
| Mean yield | | 35.6 | | | |
| LSD .05 | 8.2 | 11.3 | | | |

**1964: Date Planted - April 15**
**Date Harvested - July 24**

STANDARD VARIETY BARLEY TRIALS, RANGE FIELD STATION, COTTONWOOD, 1963-1964

| Variety | 1963 Average Yields, | 1964 | 1963-1964 bu/acre | 1964 Test Wt. lb/bu | Statistical Significance |
|---|---|---|---|---|---|
| Custer | 18.5 | 36.4 | 27.5 | 45.0 | |
| Otis | 22.4 | 36.0 | 29.2 | 47.0 | |
| Larker | 22.1 | 33.4 | 27.7 | 48.5 | |
| Plains | 11.6 | 31.0 | 21.3 | 48.5 | |
| Betzes | 31.3 | 27.1 | 29.2 | 47.0 | |
| Spartan | 24.0 | 22.9 | 23.5 | 45.5 | |
| Traill | 25.8 | 22.4 | 24.1 | 47.0 | |
| Trophy | 21.0 | 19.5 | 20.3 | 46.1 | |
| Feebar | 17.3 | 18.9 | 18.1 | 44.5 | |
| Kindred | 15.0 | 14.5 | 14.8 | 46.5 | |
| Liberty | 20.9 | 13.5 | 17.2 | 47.0 | |
| Parkland | 21.0 | 12.6 | 16.8 | 46.5 | |
| | Mean yield | 24.0 | | | |
| LSD .05 | 5.9 | 5.1 | | | |

1964: Date Planted - April 15
Date Harvested - July 24

GRAIN SORGHUM PERFORMANCE TRIAL, AREA B3, RANGE FIELD STATION, 1964

| Variety | Percent Moisture | Height Inches | Date Headed | T.Wt. lb/bu | Yield, 100#/A 1964 | 1962-64 | Statistical Significance |
|---|---|---|---|---|---|---|---|
| SD 451 | 6.8 | 33 | 7/25 | 54 | 7.9 | 7.6 | |
| Pawnee | 8.5 | 33 | 7/28 | 56 | 7.7 | | |
| NK 120 | 7.0 | 28 | 7/24 | 50 | 7.5 | 7.9 | |
| NK 133 | 6.9 | 33 | 7/28 | 54 | 7.2 | | |
| RS 501 | 5.8 | 36 | 7/28 | 55 | 7.0 | 5.7 | |
| NK 125 | 6.3 | 31 | 7/28 | 53 | 6.3 | 7.1 | |
| TE 44 | 7.4 | 26 | 7/31 | 49 | 6.3 | | |
| PAG 304 | 7.3 | 24 | 7/29 | 55 | 6.1 | | |
| NK 144 | 8.6 | 28 | 7/30 | 55 | 6.0 | | |
| SD 441 | 7.5 | 35 | 7/23 | 52 | 5.7 | 4.5 | |
| DeKalb Shorty 33 | 5.1 | 28 | 7/25 | 56 | 5.6 | | |
| DeKalb B32 | 8.2 | 31 | 7/29 | 58 | 5.5 | | |
| SD 503 | 7.0 | 32 | 7/30 | 53 | 5.5 | 6.2 | |
| SD 102 | 6.1 | 32 | 7/22 | 52 | 5.1 | 4.9 | |
| SD 502 | 7.2 | 30 | 7/29 | 53 | 5.0 | | |
| PAG 275 | 6.5 | 30 | 7/25 | 54 | 4.8 | | |
| RS 610 | 10.0 | 31 | 8/2 | 53 | 4.1 | 3.9 | |
| RS 608 | 9.3 | 27 | 8/4 | 53 | 3.0 | 3.6 | |
| Comanche | 9.7 | 29 | 8/3 | 53 | 2.5 | 2.9 | |
| NK 212 | 14.0 | 29 | 8/5 | 51 | 2.0 | | |
| Ute | 9.9 | 27 | 8/5 | 52 | 1.7 | | |
| Pioneer 848 | 6.9 | 29 | 8/13 | 52 | 1.0 | | |
| | | | Mean Yield | | 5.2 | | |
| CV - 46% | | | L.S.D. (.05) | | 3.9 | | |

Drouth conditions and some bird damage caused a coefficient of variation so high that statistical differences found are unreliable.

1964: Date Planted - May 26; Date Harvested - September 29.

**Temperature and Precipitation Data for 1964 Grain Sorghum Growing Season**
**Cottonwood**

First frost $32^{o}$ - Sept. 24

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cottonwood | May | 60.6 | 3.2 | | 2.55 | -0.16 | |
| 2 E | June | 65.1 | -2.0 | | 5.31 | 2.33 | |
| | July | 77.2 | 1.6 | | 0.87 | -0.67 | |
| B3 | Aug. | 70.8 | -3.0 | | 1.36 | 0.00 | |
| | Sept. | 59.9 | -3.1 | 0.6 | 0.17 | -0.85 | 0.65 |
| | | | | | 10.26 | | |

SOIL FERTILITY STUDIES, RANGE FIELD STATION

Dwight Hovland

Soil fertility plots were revised in 1961 and 1962. One set of plots was started to test rates of nitrogen fertilization with yields from a winter wheat-fallow sequence. A second group of plots was established to determine the influence of nitrogen and phosphorus fertilization on yields from a spring wheat-sorghum sequence and a spring wheat-fallow sequence.

Results from 1964 are shown in the table below. Fall sown wheat did not survive the winter and, during the growing season, the soil became too dry to produce a crop of sorghum. Spring wheat yields in the fallow sequence increased with phosphorus fertilization of the soil.

Influence of Fertilizer on Spring Wheat Yield in a Spring Wheat-Sorghum Sequence and in a Spring Wheat-Fallow Sequence - Cottonwood 1964

| Fertilizer | | Sequence | |
|---|---|---|---|
| N | P | Sorghum | Fallow |
| (Lbs/A) | | (Bu/A) | |
| 0 | 0 | 11 | 9 |
| 30 | 0 | 9 | 9 |
| 0 | 13 | 11 | 15 |
| 30 | 13 | 8 | 14 |

COTTONWOOD GRASS VARIETY STUDIES

James G. Ross

Tests of grass varieties in rows and in solid stands have been conducted to obtain information concerning adaptation and yield. Nordan and Fairway crested wheatgrass and Vinall Russian wildrye have persisted better than other grasses. They have also given forage earlier in the spring. Lincoln bromegrass and Oahe intermediate wheatgrass have been superior in forage yields. Because of drought and uneven stands, comparative yield data were not available in 1964.

AGRICULTURAL ADVISORY GROUP

U. S. Irrigation and Dryland Substation
Newell

| | |
|---|---|
| Laurence Bentz - Newell | Louis Bober - Rapid City |
| Rodney Larson - Fruitdale | James Oliver-Albion, Montana |
| E. H. Renecke-Beulah, Wyoming | Norman Vansickle - Opal |

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THE COOPERATIVE EXTENSION SERVICE
South Dakota State University
John T. Stone, Director

County Extension Agents of the Substation Area

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| Elbert Bentley | Bison | Perkins County |
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Walter C. Morgan, Professor, Poultry Science, SDSU
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Contents *



* Work reported herein belongs primarily to the areas of responsibility discharged by the South Dakota Agricultural Experiment Station in its cooperative research program with the United States Department of Agriculture and the Agricultural Research Service.

# INTRODUCTION

Carl Erickson
Superintendent

The Newell Field Station in Butte County, South Dakota, has been a research center for the past 57 years serving an extensive area of northwestern Nebraska, eastern Wyoming, and western South Dakota. The Bureau of Plant Industry of the United States Department of Agriculture initially established the Belle Fourche Experiment Farm in 1907. In 1950 the name was changed to the Newell Irrigation and Dryland Field Station.

The Station is concerned with research in soil, water, livestock and range improvement primarily on the heavy clay soils of western South Dakota under both irrigated and dryland conditions. The Agricultural Research Service, United States Department of Agriculture, and the South Dakota Agricultural Experiment Station cooperate in the research. The Federal government is responsible for maintenance and operation of the Station and for research in soil and water. The South Dakota Agricultural Experiment Station is responsible for livestock and range utilization and improvement research.

Twelve hundred acres of range land at Fort Meade, 25 miles south of Newell in Meade County, are supervised by station personnel in connection with grazing experiments. Heifers from the beef breeding project are wintered at Cottonwood, in Jackson County, and grazed during the summer at Fort Meade. At 18 months they are returned to the parent herd at Cottonwood or Antelope Range. In addition, steers utilized in calf wintering and feedlot studies at Newell are summered at Fort Meade.

Soils at the Newell Field Station are Pierre clays and allied soils. Pierre clays are residual soils developed from underlying Pierre shales and are exceptionally heavy soils ranging in texture from a silty clay loam through a heavy clay. Pierre clay soils are dark grayish brown in the upper layers, shading into the olive-gray color of the parent material at depths of 3-1/2 to 6 feet. On level uplands and on bottomlands where drainage is imperfect, soil formation has been influenced by the accumulation of salts. Natural fertility of Pierre clay soils is adequate even though the organic matter content is low. Water permeability is very poor. In a study of the movement of water through an undisturbed core of Pierre clay soil, it was observed that after 29 days water had penetrated to a depth of only 6 inches. Initially, water entered the soil at a rate of 0.53 inches per hour; however, after the first hour the rate of entry was 0.05 inches per hour and continued to decrease to a constant value of 0.01 inch per hour at the twentieth day.

Due to high clay content of 34% to 54%, Pierre clay soils become sticky and plastic on wetting and are easily puddled. At low-moisture content these soils are hard and coherent. Clods are produced if these soils are tilled in either a wet or a dry condition. Because of cohesive characteristics, Pierre clay soils are quite resistant to wind action when wet or moist. Frost action, in conjunction with the drying effect of wind during the winter and early spring, often breaks the soil into a loose mass of granulated particles which are easily eroded.

Annual precipitation from 1908 through 1956 averaged 15.67 inches, ranging during this 49-year period from 28.41 inches in 1946 to 6.64 inches in 1911. Average rainfall during the growing season (April through September) is 12.04 inches. Temperatures at the station during this period ranged from a high of 110° F. to -38° F. Average temperatures during June, July and August were 65° F., 73° F., and 70° F., respectively. The average frost-free period is 137 days.

## LIVESTOCK RESEARCH

J. A. Minyard

### The Research Program Prior to 1961

Livestock research has been one major line of investigation at Newell for many years. From 1912 to 1922 it was conducted in cooperation with the Bureau of Animal Industry, USDA, and since then by the Experiment Station.

Early livestock work was closely tied in with irrigation farming studies and was primarily concerned with management and utilization of irrigated crops. A feeder pig project, initiated in 1915, created considerable local interest and led to the development of a thriving feeder pig industry in the early twenties. A small flock of Hampshire sheep was started in 1920 and maintained until 1942, when it was replaced by a flock of purebred Corriedales from USDA foundation stock. The Corriedale flock was maintained until 1961.

Lamb Feeding:

Lamb feeding trials were started in 1927 to answer questions regarding ration composition, methods of handling feeds, supplements in finishing rations, and management of lambs. Farm grown feeds were fed in different combinations, with and without protein and mineral supplementation, in an attempt to find efficient rations for fattening lambs. A brief summary of major findings:

1. Sorghum fodder, western wheatgrass hay and sudangrass hay, with or without protein supplement, were poor substitutes for alfalfa hay.

2. Lambs fed corn gained faster and utilized the feed more efficiently than lambs fed barley.

3. Chopping hay reduced the feed required per pound of gain. However, the returns from feed saved were not enough to offset the cost of chopping.

4. Addition of cobalt to finishing rations increased rate of gain and feed efficiency. Response was greatest when prairie hay was fed as roughage.

5. Use of hormone implants increased rate of gain and improved feed efficiency; however, carcass quality of treated lambs was lowered.

6. "Topping out" lambs as they became finished for market proved a profitable practice.

7. Feedlot room allowed per lamb (25 square feet vs. 80 square feet) did not significantly affect death loss or feedlot performance of feeder lambs.

8. Feeding three times a day showed no advantage over feeding twice daily.

Wintering Ewes:

Use of alfalfa hay and native hay for wintering bred ewes was evaluated, starting in 1945. In terms of ewe gain and lamb and wool production, a daily allowance of 2.5 pounds of native hay and 1.0 pound of alfalfa hay was equivalent to 3.5 pounds of alfalfa hay. Feeding a similar ration to ewe lambs for the first two winters did not prove satisfactory. However, when 1/3 to 2/3 pound of barley was fed with 1.0 pound of alfalfa hay and 2.0 pounds of wheatgrass hay for the first winter and followed the second winter by an all-hay ration, a satisfactory cumulative 2-year performance was obtained.

Irrigated Pasture Studies:

Research was initiated in 1950 to evaluate livestock production on irrigated pastures. Plots on heavy clay soils ranged in size from 7 to 9 acres. The land was class IV, with undeveloped topography and water distribution system. The plots were managed as a seven-unit pasture-crop rotation, and the experiment was continued for 9 years. Each pasture was divided by a temporary fence, half the pasture for sheep and half for cattle.

Carrying capacity of the irrigated pastures averaged 5.55 animal unit months[1] (AUM) per acre for sheep, 4.09 for yearling steers grazed, and 5.20 for yearling steers fed green-chop. The average grazing period was 116 days. The cattle were fed green-chop for an average of 98 days. Total animal gains per year averaged 290, 285 and 351 pounds per acre for sheep grazed, steers grazed and steers fed green-chop, respectively.

Swine Breeding and Feeding:

Early work with swine was limited to full feeding practices on alfalfa pasture, and to utilization of grain, tankage and alfalfa hay by both spring and fall pigs. Feeding trials on pasture compared the use of either wheat or corn as the only grain in otherwise balanced rations. In two season's comparisons, pigs fed wheat gained more rapidly and efficiently than pigs fed corn.

In 1943 a project on swine breeding, feeding and management was initiated to study methods of maintaining a high-producing herd. A closed herd of Hampshires was used. This herd was maintained as an inbred line through the 1953 season, with the exception of one outcross in 1946. By 1953 inbreeding had been raised to 40% in the pigs, an average increase of 4% for each generation. During that same period selections for the breeding herd were based on an index for total productivity. In spite of the rather rigid selection, livability of pigs and individual growth rate decreased as the level of inbreeding was raised. By 1953, livability of the pigs was so low that it was difficult to maintain the line. Because of this difficulty the line was moved to the main experiment station at Brookings. Although this line was not a high producer, it was found to be valuable in a rotation crossing program.

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[1] Animal unit months, one animal unit for one month. Five ewes, or 10 lambs or 1-1/2 yearling steers are considered one animal unit.

## Current Livestock Research

After considerable study of ways through which the research program could best serve livestock producers, a major revision started in 1960. Changes made were generally consistant with recommendations of the station's advisory council.

The purebred Corriedale flock maintained on the station since 1942 was dispersed. The better Corriedale ewes were sold and those considered unsatisfactory for purebred ewes were incorporated into a newly-formed commercial ewe flock. The Corriedale ewes along with Rambouillet ewes from the Antelope Station were mated to Polled Rambouillet rams in 1961. The following year more Rambouillet ewes were added to the flock and all ewes were mated to Columbia rams. The current commercial ewe flock is utilized in a genetic study as well as in management and nutrition investigations.

In 1961 the swine work was transferred to other state research units. Most of the portable swine facilities were either sold or moved to other locations. Permanent swine facilities at the station are presently being used for sheep.

A major change in livestock work at Newell was initiation of beef cattle research in 1961. A 16-lot experimental unit was constructed and calf wintering trials and feedlot studies have been conducted. The Newell beef cattle facilities are open feedlots located on a slope with a good shelterbelt on the north side. No sheds are provided.

The present Newell livestock research program includes four on-station and three off-station projects conducted cooperatively with private ranchers.

### Beef Cattle Nutrition:

Beef cattle research, now in its fourth year, includes a study of the effects of level of nutrition, ration composition and methods of feeding on growth, development and feedlot performance. Particular emphasis is given two general areas of beef production: wintering beef calves and feedlot performance of beef cattle. Calf wintering studies have dealt with ration composition and level of nutrition as they affect winter gains and post-winter performance, both on pasture and in the feedlot. Feedlot studies have compared different concentrates to roughage ratios and full versus limited feeding in finishing yearling steers. Stilbestrol implants, both in calves and yearlings, have been evaluated.

### High Concentrate Rations for Wintering Calves:

Wintering rations for beef calves are usually built around low-cost roughages, either winter range or hay. However, when hay supplies are short and high in price compared to grain, consideration may be given to substituting grain for hay in calf wintering rations. The two trials reported here were conducted to evaluate the feasibility of substituting grain for all or part of the hay in the wintering ration of weaned calves fed to gain 0.75 to 1.25 pounds per head daily.

### 1961-62 Trial:

Forty-eight good to choice Hereford steer calves averaging about 425 pounds were assigned to six lots of 8 calves each, three treatments with two lots per treatment. The experiment started November 6 and continued for 196 days.

Winter rations were: (1) all hay, (2) 75% hay - 25% barley, and (3) 50% hay - 50% barley. The hay was approximately a 50-50 mixture of alfalfa and prairie hay, fair to good in quality and coarse-chopped. The all-hay calves were fed to gain 0.75 to 1.00 pound per head daily. For those calves receiving grain, barley was substituted for hay in the ration on the basis of total digestible nutrient (TDN) content, 1 pound of barley replacing about 1.65 pounds of hay. After the winter trial ended, steers were summered on grass at Fort Meade from May 21 to October 8, a period of 140 days.

Performance of the steers during the winter period and the following summer grazing season is summarized in table 1. Winter gains were slightly greater for the grain-fed calves, with little difference between groups fed 25% or 50% barley. Feed costs per 100 pounds of winter gain were almost the same for all groups when hay was valued at $20 per ton and barley at $2 per hundredweight. On the basis of feed required per 100 pounds of gain, 100 pounds of barley was equal to 208 pounds of mixed hay.

Summer gains on pasture were similar between winter treatment groups. Steers wintered on a ration containing 25% barley gained slightly more on pasture. However, the differences were small and indicated that restricting the amount of a high energy feed apparently did not affect subsequent performance of the cattle.

1962-63 Trial:

Ninety-three Hereford steer calves averaging approximately 400 pounds were allotted to four treatments, two lots per treatment. The experiment started December 6 and continued for 140 days. The rations were: (1) all hay, (2) two-thirds hay and one-third barley, (3) one-third hay and two-thirds barley, and (4) all barley.

The hay was estimated to be about 60% good quality prairie hay and 40% alfalfa hay, chopped and mixed. The all-hay calves were full-fed. For those groups receiving grain, the substitution of grain for hay was made on the basis of estimated net energy content, 1 pound of barley replacing about 1.85 pounds of mixed hay. Steers wintered on barley alone were fed some hay for the first two weeks of the trial to get them on the all-barley ration.

Following the winter trial, half of the calves were turned to grass while the others were placed in the feedlot to evaluate effects of winter treatment on subsequent performance under two different management systems. The steers sent to summer pasture ran together for 148 days. Steers placed in the feedlot were finished on a mixed ration containing 80% rolled barley and 20% hay.

The barley fed in all trials, wintering and feedlot, was steam rolled with 1500 I.U. of vitamin A added per pound. In 1962-63 molasses was added to the barley at the rate of 5%. No protein supplements were fed in either the wintering or feedlot trials. Periodic analysis of the feeds indicated that all rations contained adequate levels of crude protein. Trace mineral salt and salt-bonemeal or a salt-bonemeal-ground limestone mixture were provided free-choice.

Winter gains and feed costs, summer feedlot gains and summer pasture gains are shown in table 2. There were only small differences in rate of gain among the treatment groups. Calves fed a ration of one-third hay and two-thirds barley gained slightly more.

Feed costs per pounds of gain favored hay-fed calves with the costs being highest for the calves fed all barley. Feed costs were somewhat lower than those in the preceding trial. Differences observed between the two trials in this respect may be due, in part, to differences in quality of hay, level of feeding and length of the winter feeding period. On the basis of feed required per 100 pounds of gain, 100 pounds of barley was equal to 186 pounds of mixed hay in this trial.

As might normally be expected, the calves that gained the most during the winter showed the least gain the following summer. Differences in winter gain were generally offset by differences in summer gain. Total gain for winter and summer (pasture or feedlot) slightly favored the hay-fed calves. Among the steers placed in the feedlot immediately following the winter trial, the calves wintered on hay alone showed a 27-pound advantage in total gain compared to calves fed barley alone. These results are based on small numbers; however, there appeared to be no major influence of winter ration on feedlot or pasture performance except as the winter ration affected weight and condition of the cattle.

Summary of Both Trials on Wintering Calves on High Concentrate Rations:

No difficulties were encountered with feeding barley as a substitute for hay on a TDN basis, or as a substitute on an estimated net average basis. The calves adapted quickly to the all-barley ration and all rations were readily consumed with no noticeable digestive disturbance.

Results indicate that beef calves can be wintered satisfactorily by substituting barley for part or all of the hay in wintering rations with no detrimental effects on winter gain provided the barley is properly supplemented with vitamin A and minerals. Considering only winter gains, these replacement values indicate that, under similar conditions, barley is worth approximately 1.95 times the value of a prairie hay-alfalfa hay mixture containing 40% to 50% alfalfa. This can be used in evaluating the economy of substituting barley for hay in calf rations. When cost of hay becomes much greater than half the price of barley, it should be economical to feed barley providing facilities, labor, and type of winter management program are suited to limited grain feeding.

Summer pasture gains were inconsistent between the two trials. In one trial summer gains favored the grain-fed calves, while in the other trial those calves fed hay alone during the winter gained faster the following summer on grass. However, average differences in summer gain for the two trials were not large and should not greatly affect the economy of substituting grain for hay in calf wintering rations.

Supplemental Grain and Sorghum in Calf Wintering Rations:

Level of winter feeding and the relationship between winter and summer gains in young cattle have been studied by several research workers. Most experiments on level of winter feeding indicate that pasture gains of yearling cattle are negatively correlated with their previous winter gain. A consideration of the influence which winter gain has on total gain (winter plus summer) is perhaps of greater concern to most cattlemen. Research results on this relationship have been inconsistent.

Another consideration of interest to cattlemen wintering beef calves is composition of relatively high-roughage wintering rations. Considerable interest has been expressed by stockmen, particularly in or near the irrigation projects, in the use of silage in growing rations. Questions most often raised deal with performance of calves on silage and efficiency of gains on high-silage rations.

Objectives of this study were: (1) To determine the influence of energy level on rate and efficiency of winter gain of weaned calves. (2) To determine the influence of rate of winter gain on subsequent summer gains, both on pasture and in the feedlot. (3) To evaluate the feeding value of sorghum silage for wintering beef calves on two levels of energy.

Ninety-six good to choice Hereford steer calves averaging about 415 pounds were randomly allotted to four treatments, two lots per treatment. The experiment started November 27 and continued for 145 days. The steers were initially split into high and low energy groups. The high energy group received 5 pounds of rolled barley per head daily while the low energy group received no supplemental grain. Half of each energy group was fed sorghum silage. The treatment combinations were: (1) all hay, (2) hay and sorghum silage, (3) rolled barley and hay, and (4) rolled barley, hay and sorghum silage.

All calves were started on hay with grain and silage being added slowly in the appropriate lots. For those groups receiving grain, daily barley allowance was raised to 5 pounds per steer and maintained near that level for the entire feeding period. Calves receiving silage were raised to 20 pounds per head daily following an adaptation period and were fed this level for most of the feeding period.

Barley was steam rolled with 5% molasses added and fortified with 1,500 I.U. of vitamin A per pound. Hay fed was estimated to be about two-thirds good quality prairie hay and one-third alfalfa hay, chopped and mixed. Sorghum silage was a forage variety, 70% moisture, 2.3% crude protein, and fair in grain content. It was stored in an open pit with concrete sides and bottom, covered with plastic. No protein supplements were fed in either the wintering or subsequent feedlot trials. Trace mineral salt and a mineral mixture were provided free-choice.

After the winter trial ended, each treatment group was randomly divided and half of each turned to pasture. The remaining steers were placed in the feedlot and finished for market. Steers were on summer pasture for 138 days. The feedlot steers were finished on a mixed ration containing about 80% rolled barley and 20% hay.

Results of Experiment:

Rate and efficiency of winter gain and subsequent performance of the cattle, both on pasture and in drylot, are summarized in table 3. Calves fed winter rations containing approximately 5 pounds of barley gained just over 1.5 pounds per head daily while the calves fed no grain averaged about 1.0 pound per head daily. Calves wintered on grain and hay gained slightly faster than those fed grain, hay and silage. However, because of an apparent error in calculating daily feed allowances, the high energy groups receiving no silage were fed about 0.5 pound more barley per head daily. This could well be responsible for the slight increase in gain. The addition of silage to the low energy rations did not influence daily gains.

In terms of winter gain and feed required per 100 pounds of gain, 2.75 pounds of sorghum silage was equivalent to 1 pound of hay. Feed costs per 100 pounds of gain did not differ greatly among the treatment groups, being slightly higher for the low energy groups. No difficulty was encountered in feeding sorghum silage at these levels. It was consumed readily throughout the course of the experiment.

Rate of gain during the summer, both on pasture and in the feedlot, was significantly influenced by rate of winter gain. The groups that gained fastest during the winter made the least gain during the summer. Steer calves receiving grain gained 81 pounds more during the winter than calves receiving no grain. On summer pasture the grain-fed calves gained 48 pounds less and in summer feedlot 52 pounds less, compared to calves that had received no grain. However, it should be noted that, despite an apparent negative relationship between winter and summer gains, increased winter gains resulted in increased total gains (winter plus summer) under both management systems.

Concentrate to Roughage Ratios for Finishing Yearling Steers:

In recent years, considerable interest has been shown in concentrate rations. Normally, good quality alfalfa hay and other roughages are produced in ample quantity in western South Dakota irrigated areas and in some years feed grain supplies are abundant. Yearly variation in types of feed available emphasizes the importance of flexibility in feeding programs. Knowledge of the effect of a particular ratio of concentrate to roughage on the rate and economy of gain is important to the cattle feeder in this area.

This two-year study was to determine effects of different concentrate-to-roughage ratios on rate and efficiency of gain and carcass grade of the finished steers.

During the winter of 1962-63, 48 yearling steers were randomly allotted to eight lots, four treatments with two lots per treatment. Average initial weight of the steers was about 795 pounds. Rations fed were: (1) 50% barley, (2) 65% barley, (3) 80% barley, and (4) 95% barley. The balance of the rations was a mixture of about 60% good quality prairie hay and 40% alfalfa. The barley was steam rolled with 1,500 I.U. vitamin A added per pound. This trial was repeated in 1963-64, except for the ration containing 50% hay. Animals were fed the same in both trials. Steers were marketed by treatment group at average weights of 1,150 pounds. Length of feeding period varied from 129 days for the higher grain groups to 161 days for steers fed 50% roughage. All lots were full-fed. Steers in both trials were provided trace mineral salt and a salt-bone-meal-ground limestone mixture free-choice.

Results of the trials are summarized in table 4. Daily gain increased as the amount of grain in the ration increased, with the largest difference being between rations containing 50% and 65% barley. Feed costs per 100 pounds of gain slightly favored the highest concentrate ration. No differences in carcass grade were found between treatment groups.

## Full vs. Limited Feeding:

Objectives of this experiment were to compare full-feeding and limited and limited-feeding of yearling steers in drylot as to (1) liveweight gains, (2) efficiency of feed utilization, (3) carcass grade, (4) outside fat cover, (5) ribeye area, and (6) return over cost of the animals and feed.

The experiment during the summers of 1963 and 1964 used 88 short yearling steers. All steers were fed a mixed ration containing approximately 80% rolled barley with vitamin A added. The limited-fed groups received about 85% of the amount consumed by the full-fed groups, adjusted for differences in liveweight. The steers were marketed by treatment groups at 1,100-1,150 pounds.

Performance of the steers is summarized in table 5. Rate of gain was substantially higher for the full-fed steers in both trials. Feed costs per 100 pounds of gain favored the full-fed groups slightly in the first trial while the reverse was noted in the second trial. Relatively little difference was noted in carcass grade and the differences were inconsistent between the two trials. The full-fed steers averaged higher in outside fat cover in both trials. Ribeye area was greater for limited-fed steers in the first trial and for full-fed steers in the second trial. Net return per steer was greater among full-fed steers in 1963 but showed a slight advantage for limited feeding in 1964.

Considering both trials, no consistent differences were found in efficiency of feed utilization, carcass grade, ribeye area, or net return. Full-fed steers gained faster, finished earlier and had more outside fat cover.

## Stilbestrol Implants for Feed Cattle

Experiments are being conducted to further evaluate influence of stilbestrol implants on performance of young, growing Hereford steers. The experiment is now in the third year. This report covers the first two year's work and summarizes the performance of 224 steers.

During each of the two years, half of the steers were implanted with 12 mg. of stilbestrol shortly after weaning to estimate the effect on winter gains and subsequent performance, both on grass and in the feedlot. Of steers placed on pasture each spring, half of each winter treatment group was implanted with 24 mg. of stilbestrol. In this manner, calves pastured following the winter trials were divided into four treatment groups: (1) no implant, (2) 12 mg. implant in the fall, (3) 24 mg. implant in the spring, and (4) 12 mg. (fall) plus 24 mg. (spring). All steers placed in the feedlot following the winter period were implanted with 24 mg. of stilbestrol.

Winter and summer pasture performance of the cattle are summarized in table 6. A 12 mg. implant shortly after weaning increased winter gains by 15% in the first trial and 24% in the second, with no apparent adverse effect on subsequent summer pasture gains. The fall implant appeared to increase gains the following summer, 9% in the first trial and 5% in the second trial.

Steers implanted in the spring with 24 mg. of stilbestrol made the greatest summer gains. There appeared to be no advantage to implanting both fall and spring. Total winter and summer gains of those steers implanted only in the fall compared favorably with the gains of steers implanted only in the spring and steers implanted both fall and spring, and exceeded gains of the control calves by 14%.

Subsequent feedlot gains were slightly lower and carcass grade was slightly higher for those steers implanted with 24 mg. of stilbestrol in the spring. The influence of spring stilbestrol implants on feedlot performance the following fall appeared to be quite small and of little practical importance.

For the steers placed in the feedlot immediately following the wintering trial, results are summarized in table 7. An implant with 12 mg. of stilbestrol at the beginning of the winter feeding period increased winter gains 20% in the first trial and 7% in the second trial with no adverse effect on subsequent feedlot performance.

## Sheep Research

A small flock of grade western ewes is maintained on the station and utilized in a genetic study as well as for management and nutrition investigations.

### Influence of Heredity in Sheep Production:

Data have been collected during the past two years in a study of heredity influence on economically important traits of sheep. Objectives of this study are:

(1) To estimate influence of heredity and environment on growth rate and carcass characteristics of sheep.

(2) To evaluate relationship among various live animal and carcass characteristics.

Each fall ewes in this study are randomly allotted to breeding groups and are bred to 6 rams. Rams remain in the breeding pastures about six weeks. For the remainder of the year the ewes are run in one group. A random half of the male lambs born are castrated so that within each sire group, performance data are collected on ram, wether, and ewe lambs. The progeny are finished for market in the station feedlots and slaughtered at the State University Meats Laboratory where detailed carcass data are collected.

The data collected to date represent a small number of offspring and only 12 sire groups. Therefore, no analyses of the data have been made.

### Influence of Antibiotic Supplementation on Lamb Livability:

Objectives of this study, initiated in the spring of 1964, are to evaluate the influence on lamb livability of supplementing ewes with an antibiotic just prior to and following lambing. One hundred and thirty-seven pregnant ewes were arrayed by weight and randomly allotted to two groups. Beginning about six weeks before the start of lambing, half of the ewes were fed a daily grain supplement containing 60 mg. of aureomycin. The other half was fed the same supplement but without the antibiotic. Supplementation was continued for 11 weeks. All ewes were shorn on March 9 and 10 and lambing started about March 20. Ewes were weighed at the beginning and after supplementation.

A summary of the effects of antibiotic supplementation is presented in table 8. Eleven percent of the lambs born in the control group died during the first month compared to a death loss of 3.5% in the treated group. Antibiotic supplementation did not affect body weight of the ewes. It is planned to repeat this experiment in 1965.

Drylot Management of Sheep:

This experiment, started in 1964, is designed to study the practicality of drylot management of sheep under farm conditions and the problems associated with this type of management. Main objective is to estimate effects on conception rate and percentage lamb crop of ewes based on levels of nutrition from the time lambs are weaned until the following breeding season.

After lambs were weaned, 122 ewes were divided into two groups. One group was run on fair to good summer pasture while the other was maintained in drylot on about 2 pounds of poor quality hay per head daily. The trial started August 8 and ended early in October when the groups were combined and placed on a flushing ration of 1 pound of barley per head daily. All ewes were exposed to rams two weeks after flushing started. From August 8 until flushing started early in October, ewes grazed gained an average of 15 pounds per head compared to an average loss of 5 pounds per head for the drylot group.

Data on conception rate and percentage lamb crop will be collected in the spring of 1965. This study will be continued for two or three years to provide reliable data for support of recommendations.

## Cooperative Field Testing Project

A cooperative bull testing project supervised from Newell is conducted in cooperation with ranchers and does not involve station land or facilities. This is part of Animal Science Project #167, "The Improvement of Beef Cattle Through Breeding," and is concerned primarily with the study of heritability, genetic correlations among economically important traits of beef cattle, effects of inbreeding, and effects of selection on beef cattle performance.

Young Hereford bulls produced in the inbreeding and selection study at the Antelope station are leased to commercial operators for field testing. These bulls, one in each cooperator herd, are mated to a random group of cows and performance of the progeny is compared with progeny from other bulls in the test herds. At weaning time a sample of steer calves from each sire used in the cooperative project is purchased and finished for market in Experiment Station feedlots. Complete feedlot and carcass data are taken. The field testing project has been in operation since 1955 and has been supervised from the Newell station since 1961.

## Grass Tetany Research

Grass tetany is a metabolic disorder of ruminants and is believed to be associated with a disturbance of magnesium and/or calcium metabolism. The disease has been reported in all classes of cattle. However, it is most frequently observed among lactating cows grazing new spring grass. Livestock losses from grass tetany are highly variable from ranch to ranch and between years. In southwestern South Dakota substantial losses are encountered most years.

A series of cooperative field trials with ranchers in Shannon County started in 1963. Major objectives were: (1) to study effects of magnesium and calcium supplementation on the incidence of grass tetany, and (2) to evaluate practicality of supplying supplemental magnesium and calcium to range beef cows.

A total of five trials have been conducted over a two-year period on three different ranches, all of which had previously experienced grass tetany losses. These trials involved more than 1,000 beef cows.

In each trial the individual herds were randomly divided into two groups about March 20 each year. One group of cows in each herd was fed a supplement calculated to supply 6 grams of magnesium and 12 grams of calcium per head daily. The remaining group, serving as control, was fed a similar supplement but without added magnesium or calcium. All cows were fed from about March 20 to May 10. In each trial the two groups grazed adjoining pastures considered to be similar with respect to the probable occurrence of grass tetany. The pelleted supplements, both control and treated, were readily consumed in all herds without noticeable scouring or other apparent digestive disturbances.

A summary of grass tetany cases reported and incidence of death from grass tetany is shown in table 9. Eighteen cases, 11 fatal, of grass tetany were reported among 505 cows in the control group. In the treated groups, totaling 504 cows, only one case of grass tetany was observed.

## Animal Identification

Individual identification of beef cattle is important in herds where production testing is used as an aid to selection. Permanent and practical means of identification among mature beef cows presents a particular problem.

Work on animal identification is being conducted at Newell and in private beef herds in this area. Several types of identification are being evaluated. Major objective is to improve current methods of beef cattle identification. Preliminary results are encouraging; however, more work is needed before recommendations can be made.

Table 1. High Concentrate Rations For Wintering Calves

| Treatment: | All hay | 75% Hay 25% barley | 50% Hay 50% barley |
|---|---|---|---|
| No. animals | 16 | 16 | 16 |
| Initial shrunk wt., lb.[a] | 427 | 426 | 423 |
| Final shrunk wt., lb.[a] | 576 | 592 | 592 |
| Av. gain, lb. | 148 | 166 | 168 |
| Av. daily gain, lb. | .76 | .85 | .86 |
| Av. daily ration, lb. | | | |
| Hay | 13.6 | 8.9 | 5.1 |
| Barley | -- | 3.0 | 5.1 |
| Feed/100 lb., winter gain, lb. | | | |
| Hay | 1797 | 1048 | 592 |
| Barley | -- | 350 | 592 |
| Feed cost/100 lb., winter gain, lb.[b] | $17.97 | $17.48 | $17.76 |
| Summer gain on pasture, 140 days | | | |
| Av. gain, lb. | 214 | 225 | 214 |
| Av. daily gain, lb. | 1.53 | 1.61 | 1.53 |
| Av. total gain (winter plus summer), lb. | 362 | 391 | 382 |

[a] Taken off water overnight, approximately 15 hours, prior to weighing.

[b] Feed prices used: barley @ $2/cwt., hay @ $20/ton.

Table 2. High Concentrate Rations for Wintering Calves

| Treatment: | All hay | 2/3 Hay 1/3 barley | 1/3 Hay 2/3 barley | All barley |
|---|---|---|---|---|
| No. animals | 24 | 24 | 23 | 22 |
| Initial shrunk wt., lb.[a] | 393 | 400 | 400 | 404 |
| Final shrunk wt., lb.[a] | 561 | 565 | 582 | 575 |
| Av. gain, lb. | 168 | 165 | 182 | 171 |
| Av. daily gain, lb. | 1.19 | 1.18 | 1.30 | 1.23 |
| Av. daily ration, lb. | | | | |
| Hay | 14.4 | 7.7 | 3.2 | 0.2[b] |
| Barley | -- | 3.8 | 6.3 | 8.0 |
| Feed/100 lb., winter gain, lb. | | | | |
| Hay | 1202 | 602 | 255 | 26[c] |
| Barley | -- | 325 | 500 | 655 |
| Feed cost/100 lb., winter gain[c] | $12.02 | $12.52 | $12.55 | $13.36 |
| Summer feedlot gain, 198 days (Drylot group) | | | | |
| Av. gain, lb. | 552 | 534 | 506 | 522 |
| Av. daily gain, lb. | 2.80 | 2.73 | 2.58 | 2.66 |
| Summer pasture gain, 148 days (Pasture group) | | | | |
| Av. gain, lb. | 261 | 254 | 235 | 242 |
| Av. daily gain, lb. | 1.76 | 1.72 | 1.60 | 1.64 |

[a] Taken off water overnight, approximately 15 hours, prior to weighing.

[b] Hay fed for two weeks to get the calves on the all barley ration.

[c] Feed prices used: barley @ $2/cwt., hay @ $20/ton.

Table 3. Supplemental Grain and Sorghum Silage in Calf Wintering Rations

| Treatment: | High Energy | | Low Energy | |
|---|---|---|---|---|
| | Silage | Hay | Silage | Hay |
| No. animals | 24 | 22 | 24 | 24 |
| Initial shrunk wt., lb.[a] | 418 | 415 | 414 | 419 |
| Final shrunk wt., lb.[a] | 639 | 647 | 555 | 568 |
| Days on feed | 145 | 145 | 145 | 145 |
| Av. gain, lb. | 221 | 232 | 141 | 149 |
| Av. daily gain, lb. | 1.5 | 1.6 | 1.0 | 1.0 |
| Av. daily ration, lb. | | | | |
| Hay | 4.0 | 9.1 | 7.0 | 13.0 |
| Barley | 4.7 | 5.3 | -- | -- |
| Silage | 14.1 | -- | 14.1 | -- |
| Feed/100 lb., winter gain, lb. | | | | |
| Hay | 260 | 570 | 722 | 1263 |
| Barley | 306 | 331 | -- | -- |
| Silage | 926 | -- | 1460 | -- |
| Feed cost/100 lb., winter gain[b] | $12.43 | $12.33 | $13.06 | $12.63 |
| Summer feedlot gain, 174 days (drylot group) | | | | |
| Av. gain, lb. | 428 | 442 | 480 | 495 |
| Av. daily gain, lb. | 2.46 | 2.56 | 2.76 | 2.84 |
| Summer pasture gain, 138 days (pasture group) | | | | |
| Av. gain, lb. | 215 | 211 | 253 | 269 |
| Av. daily gain, lb. | 1.56 | 1.53 | 1.84 | 1.95 |

[a] Taken off water overnight, approximately 15 hours, prior to weighing.

[b] Feed prices used: barley @ $2/cwt., hay @ $20/ton.

Table 4. Concentrate to Roughage Ratios in Fattening Yearling Steers

| Treatment: | 50% Barley 50% hay | 65% Barley 35% hay | 80% Barley 20% hay | 95% Barley 5% hay |
|---|---|---|---|---|
| No. animals | 12 | 26 | 27 | 28 |
| Initial shrunk wt., lb.[a] | 794 | 797 | 796 | 792 |
| Final shrunk wt., lb.[a] | 1189 | 1153 | 1147 | 1139 |
| Av. days on feed | 161 | 136 | 129 | 129 |
| Av. daily gain, lb. | 2.45 | 2.62 | 2.72 | 2.69 |
| Av. daily ration | | | | |
| Rolled barley | 13.3 | 16.5 | 19.3 | 20.7 |
| Hay | 13.2 | 8.9 | 5.1 | 1.8 |
| Feed/100 lb., gain, lb. | | | | |
| Rolled barley | 543 | 630 | 710 | 746 |
| Hay | 539 | 340 | 188 | 67 |
| Feed cost/100 lb., gain[b] | $16.25 | $16.00 | $16.08 | $15.59 |
| Carcass grade[c] | 18.0 | 18.4 | 18.4 | 18.5 |

[a] Steers off water overnight (approx. 15 hours) prior to weighing.

[b] Feed prices used: barley @ $2/cwt., hay @ $20/ton.

[c] Av. good = 17, av. choice = 20, av. prime = 23.

Table 5. Full Vs. Limited Feeding in Finishing Yearling Steers

| Treatment & Year: | 1963 Full-fed | 1963 Limited-fed | 1964 Full-fed | 1964 Limited-fed |
|---|---|---|---|---|
| No. animals | 22 | 20 | 24 | 22 |
| Initial shrunk wt., lb.[a] | 628 | 618 | 662 | 662 |
| Final shrunk wt., lb.[a] | 1143 | 1156 | 1097 | 1153 |
| Days on feed | 177 | 219 | 155 | 194 |
| Av. daily gain, lb. | 2.92 | 2.46 | 2.81 | 2.53 |
| Av. daily ration, lb. | | | | |
| Rolled barley | 18.5 | 16.3 | 18.8 | 16.3 |
| Hay | 4.6 | 4.1 | 4.7 | 4.1 |
| Feed/100 lb. gain, lb. | | | | |
| Rolled barley | 635 | 664 | 670 | 645 |
| Hay | 159 | 166 | 168 | 162 |
| Feed cost/100 lb. gain[b] | $14.29 | $14.94 | $15.08 | $14.52 |
| Carcass grade[c] | 18.7 | 18.2 | 19.3 | 19.5 |
| Outside fat, in. | .89 | .79 | .85 | .73 |
| Ribeye area, sq. in. | 11.8 | 12.2 | 12.2 | 11.4 |
| Gross return/steer | $242.48 | $236.65 | $237.97 | $247.57 |
| Average feed cost | 73.76 | 80.41 | 65.65 | 71.35 |
| Initial value/steer | 144.32 | 142.14 | 152.24 | 152.21 |
| Return--animal and feed cost | 24.40 | 14.10 | 20.08 | 24.01 |

[a] Steers off water overnight (approx. 15 hours) prior to weighing.

[b] Feed prices used: barley @ $2/cwt., hay @ $20/ton.

[c] Av. good = 17, av. choice = 20, av. prime = 23.

Table 6. Effect of Stilbestrol on Winter and Subsequent Summer Pasture Gains of Beef Calves

| Treatment: | Stilbestrol 0 | 12 mg. (fall) | 24 mg. (spring) | 12 mg. + 24 mg. |
|---|---|---|---|---|
| 1962-63: | | | | |
| Winter gain (140 days), lb. | 150 | 169 | 152 | 150 |
| Summer gain (148 days), lb. | 220 | 239 | 260 | 242 |
| Total gain (288 days), lb. | 370 | 408 | 412 | 392 |
| 1963-64: | | | | |
| Winter gain (145 days), lb. | 151 | 203 | 176 | 202 |
| Summer gain (138 days), lb. | 218 | 229 | 258 | 244 |
| Total gain (283 days), lb. | 369 | 432 | 434 | 446 |
| Avg. of two trials: | | | | |
| Winter gain, lb. | 150 | 186 | 164 | 176 |
| Summer gain, lb. | 219 | 234 | 259 | 243 |
| Total gain, lb. | 369 | 420 | 423 | 419 |

Table 7. Effect of Stilbestrol Implant on Winter Gains and Subsequent Feedlot Performance of Beef Calves

| Treatment: | Stilbestrol 0 | 12 mg. (fall) |
|---|---|---|
| 1962-63: | | |
| Winter gain (140 days), lb. | 171 | 206 |
| Feedlot gain (198 days), lb. | 528 | 522 |
| Total gain, lb. | 699 | 728 |
| 1963-64: | | |
| Winter gain (145 days), lb. | 176 | 189 |
| Feedlot gain (175 days), lb. | 458 | 467 |
| Total gain, lb. | 634 | 656 |
| Avg. of two trials: | | |
| Winter gain, lb. | 174 | 197 |
| Feedlot gain, lb. | 493 | 495 |
| Total gain, lb. | 667 | 692 |

Table 8. Effect of Antibiotic Supplementation on Weight of Ewes and Lamb Livability

| Treatment: | Control | 60 mg. aureomycin daily |
|---|---|---|
| No. animals | 67 | 70 |
| Initial wt. of ewes (2/11/64), lb. | 142 | 139 |
| Final wt., of ewes (5/18/64), lb. | 139 | 135 |
| Change in wt., lb. | - 3 | - 4 |
| No. lambs born | 100 | 113 |
| Lambs died first month | 11 | 4 |
| Percentage mortality | 11.0 | 3.5 |

Table 9. Influence of Magnesium and Calcium Supplementation on the Incidence of Grass Tetany

| Ranch No. | 1[a] | | 2[a] | | 3[b] | | Ranches Combined | |
|---|---|---|---|---|---|---|---|---|
| | Control | Treated | Control | Treated | Control | Treated | Control | Treated |
| No. cows | 190 | 190 | 295 | 294 | 20 | 20 | 505 | 504 |
| No. tetany cases[c] | 0 | 0 | 15 | 1 | 3 | 0 | 18 | 1 |
| No. deaths[c] | 0 | 0 | 8 | 1 | 3 | 0 | 11 | 1 |

[a] Represents composite totals for 1963 and 1964
[b] Cooperated in 1964 only
[c] Diagnosed and reported by each rancher

# RANGE AND IRRIGATED PASTURE RESEARCH

J. T. Nichols

Range research at Newell is relatively new, beginning in the spring of 1963 when a full time research investigator was hired. As most of the projects have been started since then, they have not been conducted long enough to obtain conclusive results.

Additional research is planned which will encompass both irrigated pastures on the station and native ranges of surrounding areas.

## Irrigated Pastures

Evaluation of Different Grasses for Irrigated Pastures:

Considerable interest has been indicated by ranchers and farmers of this area in developing efficient irrigated pasture systems. Limited information is available on this topic, especially in relation to the Pierre clay soils which are common to much of the area.

In the spring of 1963, eleven different species of grass were planted on irrigated borders at the Newell Field Station with the following objectives in mind:

1. Evaluate production characteristics of different grasses.
2. Compare forage production of grass alone, grass with alfalfa, and grass with an annual application of 100 pounds per acre of nitrogen.
3. Develop season-long grazing systems for irrigated pastures.

Five replications of each grass were established for each of three treatments: (1) grass alone, (2) grass in combination with alfalfa, and (3) grass alone with 100 pounds per acre of nitrogen applied annually. Irrigation water was applied as often as needed throughout the growing season. The plots were harvested during the 1964 growing season on June 24 and August 27.

Total forage production for 1964, shown in table 1, indicates considerable difference in production potential of different grasses. Reed canarygrass produced the greatest amount of forage on both the fertilized and non-fertilized plots and Russian wildrye the least.

Application of 100 pounds of nitrogen per acre increased forage production of all species more than 50 per cent compared to unfertilized plots. All species appeared to respond equally well to application of nitrogen. When different grasses were seeded with alfalfa, average forage production was increased 44 per cent over grass alone, but was 14 per cent less than grass alone with 100 pounds of nitrogen per acre. A difference is evident in the ability of certain grasses to produce when grown with alfalfa compared to growing alone. For example, Reed canarygrass ranked as the highest producer on both fertilized and non-fertilized plots, but was the second lowest producer when grown in competition with alfalfa. Other grasses also changed their ranking in much the same manner, suggesting that certain grasses may produce better when not seeded in combination with alfalfa, whereas other grasses may be complemented or produce equally well by the addition of alfalfa. Wheatgrasses, as a group, appeared to be the most compatible with alfalfa.

Table 1. Average Yields in Pounds Per Acre from Three Different Treatments. Oven-dry Basis. Total of Two Clippings, 1964

| Species | Treatments | | |
|---|---|---|---|
| | Grass only | Grass + Nitrogen | Grass + Alfalfa |
| Russian wildrye | 1689 | 3400 | 5599 |
| Crested wheatgrass | 2338 | 5790 | 6012 |
| Orchardgrass | 2354 | 6429 | 4939 |
| Alta tall fescue | 3190 | 8372 | 5593 |
| Pubescent wheatgrass | 3410 | 6578 | 6453 |
| Slender wheatgrass | 3530 | 7394 | 7854 |
| Intermediate wheatgrass | 3723 | 7004 | 6809 |
| Smooth brome | 3818 | 7344 | 5886 |
| Meadow fescue | 3910 | 7845 | 5387 |
| Tall wheatgrass | 4271 | 6803 | 6467 |
| Reed canarygrass | 5128 | 9483 | 5213 |
| Average | 2397 | 6986 | 6019 |

With data for only one year, no definite conclusions can be made. Additional clippings are planned in 1965 to closer approximate maximum production and to better simulate grazing conditions. Longevity of stands will be an important consideration in future years. Also, date of readiness for grazing, amount of regrowth, and period of maximum productivity will be given attention.

## Influence of Forage Species and Land Development on Livestock Production from Irrigated Pastures

Recognizing the need for additional information concerning irrigated pastures, a study started in the spring of 1963 had these objectives:

1. Determine influence of land development on forage yields and livestock production from irrigated pastures.
2. Determine economic feasibility of bench leveling class IV land on the Belle Fourche project and similar areas.
3. Determine influence of forage species on yield and livestock production from irrigated pastures.
4. Evaluate economics of irrigated pastures for livestock production.
5. Study performance of early and late season lambs on irrigated pastures.
6. Study feasibility of fattening lambs on irrigated pastures.
7. Determine effect of grazing on subsequent forage production.

All land was prepared for seeding in the fall of 1962 and seeded in the spring of 1963 to a brome-orchard grass mixture, both with and without alfalfa as a companion crop. Good stands were established on all pastures. Preliminary data, prior to initiating grazing trials, were collected in 1963 on the application of irrigation water with the following conclusions:

1. Management of irrigation water on the developed area required considerably less time and labor than on the undeveloped land.
2. Four inches is near the minimum application that can be made on either developed or undeveloped land.

3. Benches should be as near level as possible with facilities to drain water if necessary.
4. Maintenance of escarpment and border ridges are a major concern.

Plots were clipped in 1964 to estimate forage production (table 2).

Table 2. Tons per Acre of Forage (Air-dry) Produced on Developed Versus Undeveloped Land

| | Brome-orchard Mixture* | Alfalfa-brome-orchard Mixture** | Average |
|---|---|---|---|
| Developed | 1.11 | 2.17 | 1.64 |
| Undeveloped | 1.37 | 2.22 | 1.80 |
| Averages | 1.24 | 2.20 | |

* One clipping ** Two clippings

Negative results are indicated for forage production of developed land compared to undeveloped land. Approximately nine per cent more forage was produced on the undeveloped land. The cutting and filling required for developing level benches has had an adverse effect on the soil. However, this situation should become less critical in the future as soil conditions become more normal. The grass mixture with alfalfa outproduced grass alone by 17 per cent when averaged over both developed and undeveloped land. However, the alfalfa-grass mixture was harvested twice, compared to once for the grass mixture. Sufficient re-growth of grass was not made to warrant additional clipping.

Grazing trials using sheep and/or cattle are scheduled to start in the spring of 1965 and will encompass many of the objectives as outlined previously.

## Range Research

Effects of Nitrogen Fertilization and 2,4-D Application on Recovery of Depleted Range on Dense Clay Range Site:

As a result of several dry years, plus overgrazing, thousands of acres of native range on the Pierre clay soils were in a depleted condition by 1961. Much of the area was devoid of any kind of vegetation. Perennial grasses were in a low state of vigor and appeared to be dead in many cases. With abundant precipitation, in the spring of 1962, the range was occupied primarily by weeds which grew rapidly. Vegetation on dense clay range sites in good condition is typically comprised of western wheatgrass with some green needlegrass.

This study was started in the spring of 1963 to determine if reducing weed competition by spraying with 2,4-D and adding nitrogen to encourage growth of perennial grasses, would provide the environment for a more rapid recovery of the range.

The abundance of perennial grasses in relation to weeds and yields of forage were used as a measure of treatment effects. Frequency of occurrence was used to indicate the relative abundance of perennial grasses and weeds. Data are expressed as percentage frequency of occurrence. Yield estimates are expressed as pounds of oven-dry forage per acre.

The nitrogen (ammonium nitrate) treatments were applied on March 28, 1963, and the 2,4-D treatments May 24, 1963. Three replications of each of the following treatments were used: four levels of 2,4-D (0, 1/2, 1, and 2 pounds per acre of 2,4-D equivalent); and four levels of nitrogen (0, 30, 60, 120 pounds of actual nitrogen per acre). The treatments were applied in all possible combinations of 2,4-D and nitrogen levels.

The effects of 2,4-D and nitrogen treatments on the frequency of perennial grasses and weeds are shown in table 3. In 1963, sufficient time had not elapsed since treatment to permit grasses to respond significantly to either treatment. However, in 1964 grasses were increased in frequency approximately 25 percent by application of 120 pounds an acre of nitrogen compared to no nitrogen, with correspondingly smaller increases with lighter nitrogen applications. A small increase was evident in the frequency of grasses due to 2,4-D application.

Table 3. Percentage Frequency of Occurrence of Perennial Grasses and Weeds as Affected by Nitrogen and 2,4-D

| | N I T R O G E N | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0# | | 30# | | 60# | | 120# | | Average | |
| 2,4-D | 1963 | 1964 | 1963 | 1964 | 1963 | 1964 | 1963 | 1964 | 1963 | 1964 |
| | Grasses | | | | | | | | | |
| 0 | 7.3 | 13.3 | 8.7 | 12.5 | 10.8 | 19.4 | 6.7 | 16.5 | 8.4 | 15.4 |
| ½ | 10.7 | 19.4 | 5.0 | 17.3 | 9.0 | 21.0 | 11.7 | 24.4 | 9.1 | 20.5 |
| 1 | 8.0 | 14.0 | 5.2 | 18.8 | 12.5 | 24.2 | 8.7 | 20.2 | 8.6 | 19.3 |
| 2 | 6.2 | 14.0 | 6.3 | 17.5 | 7.7 | 18.8 | 8.8 | 19.9 | 7.3 | 17.5 |
| Av. | 8.1 | 15.2 | 6.3 | 16.5 | 10.0 | 20.9 | 9.0 | 20.2 | 8.4 | 18.2 |
| 2,4-D | Weeds, Annual & Perennial | | | | | | | | | |
| 0 | 18.8 | 1.0 | 20.5 | 0.8 | 21.2 | 0.8 | 24.8 | 2.3 | 21.3 | 1.2 |
| ½ | 6.5 | --- | 10.2 | 0.2 | 10.8 | 0.4 | 12.0 | 1.0 | 9.9 | 0.4 |
| 1 | 2.5 | --- | 5.8 | --- | 4.2 | 0.2 | 4.2 | 0.2 | 4.2 | 0.1 |
| 2 | 0.8 | 0.6 | 2.5 | 0.6 | 1.5 | --- | 1.3 | 0.6 | 1.5 | 0.5 |
| Av. | 7.2 | 0.4 | 9.8 | 0.4 | 9.4 | 0.4 | 10.6 | 1.0 | 9.2 | 0.6 |

The most effective control of weeds was with 2 pounds per acre of 2,4-D which reduced weed frequencies by an average of 92 percent over the check in 1963. One-half pound of 2,4-D per acre resulted in only a 59 percent reduction in weed frequencies, with 1 pound per acre ranking between these extremes. The 1964 data has indicated that very little difference existed in the abundance of weeds regardless of 2,4-D treatments, and that weeds were not sufficiently abundant to be influential in competing with the grasses one year after treatment even in plots that had not been sprayed.

A sharp increase in frequency of perennial grasses, and an equally important decrease in the frequency of weeds from 1963 to 1964 indicates that the vegetation made a remarkable recovery irrespective of treatments. A much greater natural recovery is evident that can be attributed to either 2,4-D or nitrogen treatments alone or in combination.

The effects of 2,4-D and nitrogen treatments on forage production are inconsistant in many instances. The irregular pattern of grass cover and difficulty of sampling this spotty type vegetation can be attributed to these irregularities. However, in general, the averages for both 1963 and 1964 indicate that increases in perennial grass production could be attributed to higher levels of nitrogen and 2,4-D treatments (table 4). A substantial decrease in production was evident from 1963 to 1964 irrespective of treatments.

Table 4. Yield in Pounds Per Acre of Perennial Grasses as Affected by Nitrogen and 2,4-D Treatments
Oven-dry Basis

| | N I T R O G E N | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0# | | 30# | | 60# | | 120# | | Average | |
| 2,4-D | 1963 | 1964 | 1963 | 1964 | 1963 | 1964 | 1963 | 1964 | 1963 | 1964 |
| 0 | 249 | 346 | 406 | 259 | 755 | 336 | 518 | 431 | 482 | 343 |
| ½ | 412 | 361 | 459 | 304 | 522 | 393 | 1006 | 492 | 600 | 388 |
| 1 | 497 | 398 | 739 | 346 | 992 | 497 | 842 | 517 | 767 | 440 |
| 2 | 426 | 341 | 571 | 377 | 747 | 442 | 794 | 531 | 634 | 423 |
| Av. | 396 | 362 | 544 | 322 | 754 | 417 | 790 | 493 | 621 | 399 |

## Range Renovation Methods on Dense Clay Range Sites

Thousands of acres of native range were in poor range condition in the spring of 1962 due to drought and overgrazing. At that time, extensive areas of dense clay range sites were virtually devoid of any vegetative cover.

Eight different renovation treatments were made in the spring of 1962 in an effort to determine which practices would increase the productivity of depleted ranges. A summary of the different treatments are shown on the following page.

| No. | Species seeded | Implement | Spacing (inches) | Lbs./A P.L.S. | Mechanical Treatment |
|---|---|---|---|---|---|
| 1 | Check | (no treatments) | | | |
| 2 | Sweetclover | Broadcast | 10 | 2.5 | -- |
| 3 | Sweetclover | Grass drill | 10 | 2.5 | -- |
| 4 | | | | | Pitting |
| 5 | Western wheat-grass | Flex-planters | 36 | 1.6 | -- |
| 6 | Western wheat-grass | Flex-planters | 36 | 1.6 | Pitting |
| 7 | Western wheat-grass | Flex-planters | 36 | 1.6 | Listing |
| 8 | Western wheat-grass | Grass drill | 10 | 6.0 | -- |

Each treatment was replicated 3 times. Three deferment treatments of grazing were also incorporated into the study, which will consist of 1 year, 2 years, and 3 years deferments from grazing. The 1965 data will complete the 3 years deferment. All plots were deferred the first year of treatment in 1962.

Pitting was accomplished with notched one-way disks which left pits 58 inches long, 4 inches deep, and 16 inches between pits spaced on 36-inch contours. The broadcast sweetclover was applied with a Nesbitt drill with the flex spouts hanging free. The drilled sweetclover was planted with a Nesbitt drill with presswheels and double-disks banded openers which placed the seed approximately 1-inch below the soil surface. Treatment number 5 was planted on 36-inch centers using a John Deere tool bar with planters attached equipped with presswheels and double-disk banded openers. In treatments number 6 and 7, where seeding was done in combination with pitting and listing, the seeding was in the bottom of the pits and furrows. Listing was 2 to 3 inches deep. Treatment number 8 was seeded with the Nesbitt drill.

As a measure of treatment effects, plant frequency counts provided an index to the relative abundance of the different classes of vegetation which were grouped for convenience as perennial grasses and seeds.

No data were collected from plots which received pitting and listing treatments either alone or in combination with seeding. Immediately following treatment, heavy precipitation was received which eliminated these treatments. Pitting and listing initially effectively retarded runoff as expected. However, as the rains continued the pits and furrows silted full or were eroded away. This also destroyed new grass seedlings within the furrows and pits. The western wheatgrass which was drilled without listing or pitting survived much better. It was evident that pits and furrows on dense clay range sites would not withstand repeated rains without a dense sod to protect such mechanical treatments from erosion.

Table 5 gives a summary of plant frequency data. The frequency of perennial grass has not been increased significantly by the various renovation treatments. Planting of western wheatgrass with either the flex-planter or by Nesbitt drill has not resulted in a significant increase in grass frequency two years after treatment. Drilling of western wheatgrass resulted in good establishment as indicated by the increased grass frequency in 1963. However, by 1964 little difference was evident when compared with the check or nontreated plots. Natural recovery of the vegetation has been very rapid and generally as effective as where treatments have been imposed. Deferment from grazing has resulted in an average increase of 22 percent frequency of perennial grasses compared to grazed plots. A greater benefit was derived from deferment than from renovation treatments.

Table 5. Average Percentage Frequency of Vegetation as Affected by Renovation Treatments and Grazed vs. Deferment Treatments

| | Check | Clover Broadcast | Clover Drilled | Western wheatgrass seeded: Flex-Planter | Western wheatgrass seeded: Nesbitt Drill |
|---|---|---|---|---|---|
| | | | Perennial Grasses | | |
| 1963 | | | | | |
| Deferred* | 7.6 | 8.9 | 9.2 | 7.6 | 13.3 |
| 1964 | | | | | |
| Grazed 1 Year, (1963) | 27.0 | 29.3 | 26.3 | 27.0 | 24.0 |
| Deferred* | 39.9 | 34.3 | 26.4 | 38.1 | 42.6 |
| | | | Clover | | |
| 1963 | | | | | |
| Deferred* | | Data not available | | | |
| 1964 | | | | | |
| Grazed 1 Year, (1963) | | 47.0 | 46.7 | | |
| Deferred* | | 23.0 | 39.2 | | |
| | | | Weeds | | |
| 1963 | | | | | |
| Deferred* | 17.8 | 17.0 | 16.1 | 18.8 | 17.5 |
| 1964 | | | | | |
| Grazed 1 Year, (1963) | 13.0 | 0.7 | 1.0 | 15.3 | 17.0 |
| Deferred* | 8.6 | 10.6 | 4.0 | 6.9 | 8.0 |

* Deferred since initiation of study.

A good stand of clover was obtained by both drilling and broad-casting. Competition from clover with native grasses does not appear to be detrimental. Clover by its biennial growth habit must reseed itself every two years to maintain a stand. This was accomplished effectively in the spring of 1964. Frequency data suggest this may have been accomplished more effectively when grazed than under complete deferment (table 5). Yield data suggest much the same relationship (table 6).

Effects of treatments on forage production were not significantly different from the check except for plots which were seeded to clover (table 6). Total forage produced on these plots average 2,687 pounds per acre more than the check in 1963 but only 55 pounds per acre more in 1964 (both deferred). Where grazing had occurred in 1963, the 1964 data indicates a considerable increase in clover production over the deferred. Average production was lower in 1964 regardless of treatments. Deferment from grazing did not increase production considering all treatments. Results are inconsistent for production estimates in relation to deferment.

Table 6. Forage Production in lb./A as Affected by Range Renovation Method and Grazing vs. Deferment Treatments
Oven-dry Basis

| | | | | Western wheatgrass seeded | |
|---|---|---|---|---|---|
| | Check | Clover Broadcast | Clover Drilled | Flex-Planter | Nesbitt Drill |
| 1963 | | | | | |
| Deferred* | 864 | 2933 | 3456 | 832 | 900 |
| 1964 | | | | | |
| Grazed 1 Year, (1963) | 507 | 1125 | 1308 | 550 | 703 |
| Deferred* | 779 | 871 | 796 | 562 | 920 |

* Deferred since initiation of study.

## EGG LAYING TRIALS

Egg laying trials are carried on at the Range Field Station, Cottonwood, and at the U. S. Irrigation and Dryland Field Station at Newell. This work is reported in the section on Cottonwood. (See page 59 )

A STUDY OF THE INFLUENCE OF ARSENICALS ON THE GROWTH DIFFERENTIAL OF SEVERAL GRASS SPECIES

Harry A. Geise

The purpose of this study, begun in November 1963, is to isolate certain growth responses which previously have been observed. This response has been primarily with western wheatgrass and has occurred where Pax had been applied to the soil.

Pax is an insecticide which is a mixture of several arsenic compounds. It is sold commercially for the control of crabgrass in established lawns.

Treatments used in this study consisted of several inorganic fertilizers and a crabgrass chemical, as well as pure arsenic trioxide.

Forage samples were harvested in August 1964 to determine total production and the ratio of western wheatgrass to other species. These species consisted of green needlegrass, smooth bromegrass, crested, intermediate, and tall wheatgrass, and several broad-leaved weeds. The results are shown in the following table and are expressed as the percent of the check or untreated plots.

Influence of Arsenicals on Growth Differential

| Treatment | Percent of Check Plot | Remarks |
|---|---|---|
| Check | 100 | Untreated plot consisted of 95% western wheatgrass and 5% other species. |
| 35-0-0: Fall Application | 173 | Increased total production without change in ratio of species. |
| Spring Application | 115 | Increased total production with 8% increase of other species and a decrease of western wheatgrass. |
| 70-0-0 | 197 | Increase total production without change in ratio of species from check plot. |
| 0-35-0 | 106 | Slight increase over check area with 2% increase in ratio of western wheatgrass to other species. |
| 0-0-35 | 110 | Slight increase in total production, no change in ratio of species from check plot. |
| PAX | 159 | Increase in total production, with a slight decrease in % of western wheatgrass. |
| PAX + 70-0-0 | 229 | Increase in total production with an increase of 6% in ratio of other species to western wheatgrass. |
| $AS_2O_3$ (Spring Application) | 72 | Decrease in total production with ratio of western wheatgrass (88%) and other species (12%) changing from check plot. |
| $AS_2O_3$ + 35-0-0 (Spring Application) | 132 | Increase in total production with ratio of species similar to check plot. |

CROP PERFORMANCE TESTING

J. J. Bonnemann

Performance trials with spring small grains and grain sorghum were conducted at Newell in 1964. The small grain trials were conducted with and without supplemental moisture as gravity irrigations. The grain sorghum trial was conducted only under dryland conditions. Results presented below are from Experiment Station Circulars 165 and 167: "1964 Small Grain Performance Trials" and "1964 Grain Sorghum Performance Trials." The grain sorghum yields were seriously reduced because of bird damage and drought.

STANDARD VARIETY OAT TRIALS, DRYLAND, U. S. NEWELL FIELD STATION, NEWELL, 1959-1964

| Variety | 1959 | 1960 | 1962 | 1963 | 1964 | 1959-64[a] | 1964 Test Wt. |
|---|---|---|---|---|---|---|---|
| | Average Yields, bushels per acre | | | | | | lb/bu |
| Mo. 0-205 | 5.9 | 23.3 | 88.3 | 82.4 | 46.6 | 49.3 | 36.5 |
| CI 7454 | | | | | 44.4 | | 34.5 |
| Brave | | | | | 41.3 | | 35.0 |
| Rodney | | | 89.2 | 74.0 | 40.5 | | 37.0 |
| CI 7679 | | | | | 38.8 | | 34.0 |
| Clintland 64 | | | | | 38.5 | | 36.0 |
| Ortley | | | | 76.8 | 38.3 | | 38.0 |
| Minhafer | 3.8 | 24.6 | 79.5 | 81.3 | 38.1 | 45.5 | 34.5 |
| AuSable | | | | 77.8 | 37.9 | | 39.0 |
| Neal | | | 79.7 | 90.1 | 37.1 | | 35.0 |
| Coachman | | | | 108.9 | 36.1 | | 37.0 |
| Dupree | 6.0 | 28.1 | 83.3 | 92.0 | 36.0 | 49.1 | 35.0 |
| Dodge | | | 76.8 | 89.4 | 35.1 | | 37.0 |
| Lodi | | | | 98.4 | 34.8 | | 35.0 |
| Clintland 60 | 6.5 | 20.6 | 73.5 | 88.7 | 34.4 | 44.7 | 36.0 |
| Cherokee | | | 75.2 | 90.9 | 34.3 | | 35.0 |
| Andrew | 5.4 | 26.4 | 78.9 | 93.5 | 34.3 | 47.7 | 36.5 |
| Tippecanoe | | | | | 33.1 | | 37.0 |
| Burnett | | | 90.7 | 89.6 | 32.7 | | 37.5 |
| Nodaway | | | | | 32.6 | | 37.0 |
| Bonkee | | | | 81.3 | 32.4 | | 36.0 |
| CI 7463 | | | | | 31.9 | | 39.0 |
| Nehawka | 5.4 | 22.1 | 70.1 | 86.9 | 31.9 | 43.3 | 35.0 |
| Portage | | | | 87.4 | 31.8 | | 35.5 |
| Garry | | | 85.2 | 87.7 | 31.4 | | 35.5 |
| Garland | | | | 65.7 | 27.4 | | 35.0 |
| Putnam 61 | | | | | 25.5 | | 35.0 |
| | Mean yield | | | | 35.5 | | |
| LSD .05 | N.S. | N.S. | 11.5 | 22.3 | N.S. | | |

1964: Date of Planting - 4/15/64
Date Harvested -7/28/64

a - 1961 failure due to drought

STANDARD VARIETY OAT TRIALS, IRRIGATED, U. S. NEWELL FIELD STATION, NEWELL, 1960-1964

| Variety | 1960 | 1961 | 1962 | 1963 | 1964 | 1960-64 | 1964 Test Wt. lb/bu |
|---|---|---|---|---|---|---|---|
| | Average Yields, bushels per acre | | | | | | |
| Brave | | | | | 68.4 | | 36.5 |
| CI 7679 | | | | | 66.1 | | 35.5 |
| Andrew | | | 79.1 | 83.7 | 64.1 | | 35.5 |
| Dupree | 94.1 | 9.0 | 60.5 | 80.7 | 62.3 | 61.3 | 36.5 |
| Lodi | | | | 85.6 | 61.1 | | 35.0 |
| AuSable | | | | 90.8 | 60.7 | | 39.5 |
| Clintland 64 | | | | | 59.8 | | 36.0 |
| Mo. 0-205 | 87.3 | 8.2 | 59.4 | 79.0 | 59.7 | 58.7 | 37.5 |
| CI 7454 | | | | | 59.3 | | 34.0 |
| Ortley | | | | 86.8 | 58.1 | | 38.0 |
| Clintland 60 | 83.6 | 7.0 | 67.3 | 86.4 | 57.5 | 60.5 | 36.5 |
| Minhafer | 80.3 | 8.3 | 67.6 | 69.1 | 57.1 | 56.5 | 36.0 |
| Newton | | | | | 56.8 | | 36.5 |
| CI 7463 | | | | | 56.5 | | 39.0 |
| CI 7978 | | | | | 55.6 | | 36.0 |
| Dodge | | 10.4 | 76.1 | 82.4 | 53.8 | | 38.0 |
| Tippecanoe | | | | | 52.6 | | 36.0 |
| Coachman | | | | 94.8 | 52.0 | | 38.5 |
| Portage | 86.4 | 8.2 | 60.0 | 81.5 | 51.8 | 57.6 | 37.5 |
| Rodney | 98.8 | 8.9 | | 88.7 | 51.4 | | 37.5 |
| Burnett | 79.9 | 11.8 | 66.5 | 93.1 | 51.3 | 60.5 | 37.5 |
| Garry | 97.0 | 9.3 | 70.6 | 89.3 | 48.1 | 62.9 | 36.5 |
| Neal | | | 94.0 | 85.0 | 46.8 | | 36.0 |
| Garland | | | | 74.0 | 46.8 | | 36.0 |
| Bonkee | | | | 66.5 | 46.2 | | 37.0 |
| Goodfield | 76.5 | 8.5 | | | 46.1 | | 36.5 |
| Nehawka | 84.5 | 7.1 | 64.1 | 63.6 | 43.9 | 52.6 | 35.0 |
| | Mean yield | | | | 55.3 | | |
| LSD .05 | 6.4 | N.S. | N.S. | 13.8 | N.S. | | |

1964: Date Planted - 4/15/64; Date Harvested - July 28.

STANDARD VARIETY BARLEY TRIALS, DRYLAND, U.S. NEWELL FIELD STATION, NEWELL, 1962-1964

| Variety | 1962 | 1963 | 1964 | 1962-64 | 1964 Test Wt. lb/bu | Statistical Significance |
|---|---|---|---|---|---|---|
| | Average Yields, bushels per acre | | | | | |
| Traill | 47.5 | 41.9 | 34.6 | 41.3 | 49.0 | |
| Betzes | 51.6 | 40.0 | 31.2 | 40.9 | 50.0 | |
| Otis | 48.2 | 32.1 | 27.9 | 36.1 | 48.5 | |
| Trophy | 45.1 | 36.8 | 27.5 | 36.5 | 49.0 | |
| Liberty | 56.2 | 39.7 | 27.1 | 41.0 | 48.0 | |
| Larker | 54.2 | 35.8 | 26.9 | 39.0 | 50.5 | |
| Feebar | 37.8 | 34.4 | 25.5 | 32.6 | 46.0 | |
| Spartan | 47.6 | 43.3 | 25.3 | 38.7 | 51.0 | |
| Custer | 41.1 | 33.7 | 23.3 | 32.7 | 47.0 | |
| Plains | 49.4 | 30.4 | 23.2 | 34.3 | 49.0 | |
| Kindred | 33.6 | 30.7 | 22.5 | 28.9 | 48.5 | |
| Parkland | 44.3 | 34.2 | 20.5 | 33.0 | 50.5 | |
| | Mean yield | | 26.3 | | | |
| LSD .05 | 8.4 | N.S. | 6.2 | | | |

1964: Date Planted - April 15
Date Harvested - July 27

STANDARD VARIETY BARLEY TRIALS, IRRIGATED, U.S. NEWELL FIELD STATION, NEWELL, 1962-1964

| Variety | 1962 | 1963 | 1964 | 1962-64 | 1964 Test Wt. lb/bu | Statistical Significance |
|---|---|---|---|---|---|---|
| | Average Yields, bushels per acre | | | | | |
| Traill | 81.5 | 40.0 | 46.0 | 55.8 | 48.0 | |
| Trophy | 45.7 | 42.0 | 45.8 | 44.5 | 48.0 | |
| Custer | 65.3 | 46.3 | 44.8 | 52.1 | 46.5 | |
| Betzes | 62.1 | 46.9 | 43.2 | 50.7 | 49.0 | |
| Liberty | 61.9 | 45.0 | 42.2 | 49.7 | 48.0 | |
| Spartan | 50.2 | 47.8 | 41.7 | 46.6 | 49.5 | |
| Larker | | 43.9 | 41.5 | | 50.5 | |
| Otis | 47.3 | 40.9 | 40.2 | 42.8 | 47.5 | |
| Feebar | 63.8 | 35.5 | 36.8 | 45.4 | 45.0 | |
| Plains | 64.9 | 29.4 | 33.8 | 42.7 | 48.0 | |
| Parkland | | 45.3 | 29.0 | | 47.5 | |
| Kindred | 53.9 | 33.4 | 27.7 | 38.3 | 48.0 | |
| | Mean yield | | 39.4 | | | |
| LSD .05 | N.S. | 10.6 | 7.2 | | | |

1964: Date Planted - April 15
Date Harvested - July 27

STANDARD VARIETY SPRING WHEAT TRIALS, DRYLAND, U.S. NEWELL FIELD STATION, NEWELL, 1959-1964

| Variety | 1959 | 1960 | 1962 | 1963 | 1964 | 1959-64 | 1964 Test Wt. lb/bu | Statistical Significance |
|---|---|---|---|---|---|---|---|---|
| | Average Yields, bushels per acre | | | | | | | |
| CI 13586 | | | | 27.8 | 28.0 | | 61.0 | |
| CI 13655 | | | | | 25.5 | | 61.0 | |
| Crim | | 12.2 | 32.0 | 25.2 | 25.3 | | 58.5 | |
| CI 13654 | | | | 32.2 | 24.5 | | 60.5 | |
| Mida | 0.6 | 12.2 | 36.8 | 24.1 | 24.2 | 19.6 | 60.5 | |
| Selkirk | 0.4 | 12.9 | 33.5 | 26.2 | 23.8 | 19.4 | 56.5 | |
| Justin | | | 31.8 | 23.0 | 23.3 | | 59.0 | |
| Thatcher | 0.9 | 12.6 | 23.7 | 19.5 | 22.6 | 15.9 | 58.5 | |
| Pembina | | 12.4 | 27.7 | 29.9 | 22.0 | | 56.5 | |
| Rushmore | | 13.3 | 25.2 | 22.6 | 22.0 | | 59.0 | |
| CI 13751 | | | | 24.6 | 21.5 | | 59.0 | |
| Lee | 0.2 | 11.8 | 30.5 | 23.1 | 21.0 | 17.3 | 59.5 | |
| Canthatch | | 10.9 | 23.5 | 18.7 | 20.8 | | 59.0 | |
| Ceres | 0.8 | 11.6 | | | 18.6 | | 58.5 | |
| Marquis | 0.9 | 11.3 | 7.4 | 18.8 | 14.2 | 10.5 | 55.0 | |
| | | Mean yield | | | 22.5 | | | |
| LSD. .05 | | N.S. | 6.1 | N.S. | 8.8 | | | |

1964: Date Planted - April 15
Date Harvested - July 28

STANDARD VARIETY SPRING WHEAT TRIALS, IRRIGATED, U.S. NEWELL FIELD STATION, NEWELL, 1960-1964

| Variety | 1960 | 1961 | 1962 | 1963 | 1964 | 1960-64 | 1964 Test Wt. lb/bu | Statistical Significance |
|---|---|---|---|---|---|---|---|---|
| | Average Yields, bushels per acre | | | | | | | |
| CI 13655 | | | | | 27.8 | | 62.0 | |
| CI 13654 | | | | 32.3 | 27.3 | | 62.0 | |
| CI 13751 | | | | 32.1 | 26.4 | | 61.5 | |
| Canthatch | 41.6 | 6.5 | 36.2 | 35.5 | 26.0 | 29.2 | 60.5 | |
| Rushmore | 40.2 | 5.5 | 35.7 | 29.3 | 25.7 | 27.3 | 60.5 | |
| Crim | 43.0 | 6.3 | 34.1 | 32.5 | 23.5 | 27.9 | 61.0 | |
| Thatcher | 41.2 | | | 34.7 | 23.3 | | 59.0 | |
| CI 13586 | | | | 32.5 | 22.7 | | 61.0 | |
| Selkirk | 41.4 | 5.1 | 40.7 | 37.3 | 22.2 | 29.3 | 58.0 | |
| Lee | 41.2 | 5.2 | 37.8 | 30.5 | 21.0 | 27.1 | 60.0 | |
| Justin | | 6.2 | 36.3 | 29.7 | 20.1 | | 58.0 | |
| Pembina | 40.1 | 4.9 | 39.5 | 34.9 | 19.6 | 27.8 | 58.0 | |
| | | Mean yield | | | 23.8 | | | |
| LSD .05 | N.S. | | N.S. | N.S. | 6.9 | | | |

1964: Date Planted - April 15
Date Harvested - July 28

GRAIN SORGHUM PERFORMANCE TRIAL, AREA B3, U. S. NEWELL FIELD STATION, NEWELL, 1964

| Variety | Percent Moisture | Height Inches | Date Headed | T.Wt lb/bu | Yield, 100#/A |
|---|---|---|---|---|---|
| DeKalb B32 | 25.9 | 39 | 8/7 | 24 | 2.2 |
| DeKalb Shorty 33 | 19.2 | 36 | 8/8 | 26 | 1.6 |
| NK 120 | 38.0 | 38 | 8/1 | 17 | 2.6 |
| NK 125 | 34.3 | 37 | 8/10 | 42 | 8.9 |
| NK 133 | 26.0 | 37 | 8/8 | 16 | 3.5 |
| NK 144 | 27.9 | 34 | 8/7 | 27 | 2.7 |
| NK 212 | 9.1 | 35 | 8/17 | 24 | 5.2 |
| Comanche | 8.3 | 33 | 8/20 | 23 | 1.3 |
| Pawnee | 34.3 | 42 | 8/7 | 23 | 2.1 |
| Ute | 16.2 | 32 | 8/12 | 25 | 2.4 |
| PAG 275 | 16.7 | 37 | 8/5 | 19 | 1.2 |
| PAG 304 | 11.2 | 30 | 8/10 | 25 | 3.4 |
| Pioneer 848 | 19.3 | 35 | 8/25 | 19 | 1.2 |
| TE 44 | 31.2 | 30 | 8/14 | 25 | 7.8 |
| SD 102 | 23.1 | 38 | 7/31 | 21 | 0.6 |
| SD 441 | 13.7 | 47 | 8/2 | 20 | 1.5 |
| SD 451 | 9.4 | 41 | 8/5 | 40 | 6.1 |
| SD 502 | 33.4 | 41 | 8/8 | 19 | 1.7 |
| SD 503 | 28.9 | 42 | 8/7 | 26 | 2.2 |
| RS 501 | 13.1 | 46 | 8/8 | 20 | 1.4 |
| RS 608 | 28.4 | 34 | 8/18 | 17 | 3.6 |
| RS 610 | 13.0 | 38 | 8/12 | 30 | 4.5 |

Yields are recorded in alphabetical order by company. Very dry conditions and severe bird damage prior to harvest made statistical analysis impossible. Data are reported for purpose of record only. Date planted 5/27; harvested 9/29.

**Temperature and Precipitation Data for 1964 Grain Sorghum Growing Season**

First Frost 29° - Sept. 12

| | | | | | | |
|---|---|---|---|---|---|---|
| Newell 2 NW | May | 56.8 | 1.4 | 3.16 | 0.67 | |
| | June | 63.3 | -1.1 | 5.43 | 2.24 | |
| | July | 74.4 | 1.2 | 1.98 | 0.22 | |
| B3 | Aug. | 67.1 | -4.1 | 1.79 | 0.51 | |
| | Sept. | 56.9 | -3.5 | 0.11 | -1.03 | 2.61 |
| | | | | 12.47 | | |

Temperature and Precipitation Data for 1964 Small Grain Growing Season

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Newell 2 NW | April | 44.5 | 0.4 | | 0.78 | -0.87 | |
| | May | 56.8 | 1.4 | | 3.16 | 0.67 | |
| | June | 63.3 | -1.1 | | 5.43 | 2.24 | |
| | July | 74.4 | 1.2 | .5 | 1.98 | 0.22 | 2.26 |
| | | | | | 11.35 | | |

**Last freeze April 30 - 30°**

Aerial view of U.S. Irrigation and Dryland Field Station, Newell

Grass plots on irrigated borders at Newell

Feeding beef cattle on experiment at Newell

AGRICULTURAL ADVISORY GROUP

Reed Ranch Field Station

Presho

| | |
|---|---|
| Robert E. Adrian - White River | John Fernen - Mission |
| Andrew Dice - Witten | George Fluharty - Fort Pierre |
| H. G. Ehlers - Presho | John Glaus - Chamberlain |

Allan Kime - Burke

. . . . . . . . . .

THE COOPERATIVE EXTENSION SERVICE

South Dakota State University

John T. Stone, Director

County Extension Agents of the Range Field Station Area

| | | |
|---|---|---|
| Merle Aamot | Kennebec | Lyman County |
| James Blackketter | Burke | Gregory County |
| Louie DeSmet | Mission | Todd County |
| Robert Edwards | Murdo | Jones County |
| Raymond Eilers | Winner | Tripp County |
| Eugene Zimmerman | White River | Mellette County |

. . . . . . . . . .

Personnel

Philip Severin, Superintendent, Reed Ranch Field Station

Paul E. Collins, Associate Professor, Horticulture, SDSU

Paul H. Kohler, Professor, Animal Science Department, SDSU

Donald E. Ray, Assistant Professor, Animal Science, SDSU

## Contents



## INTRODUCTION

The Reed Ranch Field Station, located about 20 miles north of Presho, is a field laboratory devoted to the study of selenium poisoning in cattle. The most toxic areas have been mapped and fenced so as to provide high levels of selenium forage. The experiments have been devoted to a study of the use of arsenicals in the diets of cattle grazing on forage containing 5 to 15 ppm of selenium. Some experiments have been concerned with problems of selenium toxicity on reproductive phenomena in beef cattle. More recently a small band of ewes have been added to the station to explore the effect of selenium toxicity on sheep.

The superintendent at Reed Ranch is Philip Severin.

PROGRESS REPORT ON RESEARCH AT REED RANCH

D. E. Ray

## Time of Breeding Study

A study was initiated in 1957 to evaluate the effect of season of breeding on reproduction and performance traits of cattle. Two breeding seasons were initially studied - an "early" group with bulls turned in with cows about May 1, and a "late" group with bulls turned in about July 18. The length of the breeding period was 10 weeks for each group. Approximately an equal number of cows from each group were allotted to each bull utilized for breeding.

Results from the first five years of this study (1958-62 calf crops) have been analyzed and published (J. Animal Sci. 22:1043, 1963). Early breeding resulted in approximately a 22% higher calf crop born and a 20% advantage in calf crop weaned. Corrected weaning weights and scores for conformation, condition and selenium poisoning symptoms, were not significantly affected (table 1).

A slight revision of the study was made in 1963. Three times of breeding were established and the number of cows in each group was increased. Breeding started on May 1 in the "early" group, June 1 in the "normal" group, and July 1 in the "late" group. Each breeding period was two months in length. The results for the last two years are summarized in table 2.

Percent calf crop born in 1963 did not differ appreciably between the two groups and was the highest observed since 1959. Percent calf crop weaned favored the late calving group. Adjusted weaning weights and scores for conformation and condition were comparable between the two groups. Selenium poisoning symptoms were more noticeable in the late group than in the early group.

In contrast, the percent calf crop born was approximately twice as high in the early group as compared to the late breeding group the subsequent year. The same trend was also noted in percent weaned, although death losses were higher in calves from the early bred cows. Adjusted weaning weight favored the early group by an average of 50 pounds. The normal group was intermediate for percent calf crop and adjusted weaning weight. Scores did not differ appreciably among the three groups.

The large differences in production traits between years may indicate that percentage calf crop is adversely affected following years of relatively high selenium damage, as reflected by symptoms in the calves. There is also a need for more precise control and evaluation of other factors (pasture differences, moisture, temperature, etc.) which may influence calf crop and growth.

## Winter Feeding Trials

During the winters of 1961-62 and 1962-63 dry-lot feeding trials were conducted at Reed Ranch. Rations fed and groups involved are indicated in table 3. All groups except the bull calves were divided into two lots, one lot receiving approximately 15 ppm Se in the ration and the other lot serving as a control less than 2 ppm Se. All bull calves received 15 ppm Se in their ration. The test period was 141 days in 1961-62 and 158 days in 1962-63. Yearling bulls were semen tested prior to and following the feeding period to evaluate changes in semen quality during the feeding trials. The results of these trials are presented in tables 4 through 7.

Lots receiving 15 ppm Se in the ration gained at a faster rate than did those receiving the low selenium ration during 1961-62. However, during the following winter the "control" lots excelled in rate of gain as compared to the "selenium" lots. It was expected that a high level of selenium in the ration would depress growth; therefore, the results obtained in 1961-62 are difficult to explain. No evidence of mistakes in formulating rations or in feeding were observed.

Evaluation of semen in the yearling bulls indicated a decline in semen quality in animals receiving a high selenium ration during the 1961-62 feeding period. Results from the 1962-63 trial were not consistent with the previous year and showed little if any effect of selenium on semen characteristics.

Studies with Sheep

Due to the inadequacy of experimental information on sheep grazing seleniferous ranges, an experiment was initiated in the fall of 1963 to evaluate the effects of selenium ingestion on growth and reproduction in sheep.

A group of 120 yearling western ewes were divided into two lots. One lot received seleniferous alfalfa hay produced at Reed Ranch during the wintering period and grazed an area relatively high in selenium during the summer period ("selenium" group). The other lot was wintered on alfalfa hay produced in a non-seleniferous area and grazed an area comparatively low in selenium during the summer ("control" group).

The wintering phase encompassed the period from breeding through lambing (November through May) and was conducted under dry-lot conditions. A difference was noted in the protein and carotene contents of the hay fed to the two groups approximately midway through the wintering phase. Therefore, the "selenium" group was supplemented with one pound dehydrated alfalfa meal per ewe daily through the remainder of the wintering period to correct the differences in nutritional value of the hay.

The results of the first year's study are summarized in table 8. Reproductive performance was lower in the selenium group than in the control group. More data will need to be collected before the significance of this difference can be evaluated. Also, the difference in feeding value of the hay noted above may have contributed to the lower performance in the selenium group.

Abnormally high lamb death losses were noted in the period from one week of age to weaning. Most of these losses were not apparent until the lambs were weaned. Approximately 35 lambs were lost during the month prior to weaning, and it was assumed that the majority of these losses were due to predatory animals.

Weaning weights corrected for age and sex of lamb did not differ appreciably between the two groups.

Table 1. Number of Matings and Average Performance By Years for Early and Late Bred Groups

| Item | 1958 | | 1959 | | 1960 | | 1961 | | 1962 | | All years | | Overall total or avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | |
| No. of matings | 15 | 14 | 10 | 10 | 11 | 12 | 12 | 12 | 27 | 29 | 75 | 77 | 152 |
| Percent born | 46.7 | 14.3 | 90.0 | 90.0 | 45.5 | 33.3 | 66.7 | 25.0 | 59.3 | 37.9 | 60.0 | 37.7** | 48.7 |
| Percent weaned | 40.0 | 14.3 | 90.0 | 80.0 | 36.4 | 25.0 | 58.3 | 25.0 | 48.1 | 31.0 | 52.0 | 32.4** | 42.1 |
| Weaning wt.[a] | 436 | 334 | 468 | 394 | 434 | 362 | 416 | 383 | 437 | 383 | 440 | 380 | 417 |
| Adj. weaning wt.[b] | 420 | 447 | 443 | 419 | 412 | 376 | 387 | 407 | 399 | 393 | 411 | 405 | 409 |
| Conformation[c] | 10.3 | 10.0 | 10.4 | 10.9 | 10.2 | 9.7 | 9.6 | 11.0 | 9.5 | 10.1 | 9.9 | 10.4 | 10.1 |
| Condition[d] | 7.7 | 7.5 | 7.0 | 7.6 | 7.0 | 5.0 | 6.3 | 6.7 | 6.8 | 6.9 | 6.9 | 6.9 | 6.9 |
| Se. symptoms[e] | 12.7 | 12.5 | 11.6 | 11.5 | 9.2 | 11.0 | 12.8 | 13.0 | 12.1 | 12.5 | 11.9 | 12.1 | 12.0 |

** $P < .01$.

[a] Adjusted for sex and age of dam.

[b] Adjusted for sex, age of dam and age of calf.

[c] Ranked on a scale from 0-17, with 17 indicating the most desirable conformation.

[d] Ranked on a scale from 0-14, with 14 indicating the highest condition.

[e] Ranked on a scale from 1-13, with 13 indicating no symptoms.

Table 2. Effect of Season of Breeding on Performance Traits of Beef Cattle

| Trait | 1963 Early | 1963 Late | 1964 Early | 1964 Normal | 1964 Late |
|---|---|---|---|---|---|
| No. matings | 31 | 32 | 39 | 36 | 36 |
| Percent born[a] | 67.7 | 71.9 | 69.2 | 58.3 | 33.3 |
| Percent weaned | 45.2 | 59.4 | 56.4 | 36.1 | 33.3 |
| Weaning wt.[b] | 393 | 325 | 421 | 379 | 338 |
| Adj. weaning wt.[c] | 359 | 360 | 415 | 381 | 365 |
| Conformation score[d] | 8.6 | 9.2 | 10.4 | 10.5 | 10.1 |
| Condition score[e] | 6.1 | 5.7 | 7.1 | 6.8 | 6.6 |
| Se symptom score[f] | 11.1 | 9.5 | 12.4 | 12.5 | 12.3 |

[a] Includes cows diagnosed pregnant that were sold or died between breeding and calving.

[b] Actual weaning weights.

[c] Adjusted for sex, age of dam and age of calf.

[d] Ranked on a scale from 0-17, with 17 indicating the most desirable conformation.

[e] Ranked on a scale from 0-14, with 14 indicating the highest condition.

[f] Ranked on a scale from 1-13, with 13 indicating no symptoms.

Table 3. Rations Fed in Winter Feeding Trials at Reed Ranch

| Group | Bull Calves | Yearling Bulls[a] | Heifer Calves[a] | Yearling Heifers[a] | Two-year-old Heifers[a] |
|---|---|---|---|---|---|
| Daily Ration (lbs.): | | | | | |
| rolled oats | 4 | 9 | same as | 6 | same as |
| alfalfa hay | 4 | 9 | bull | 6 | yearling |
| prairie hay | 4 | | calves | 6 | heifers |
| Years | 1961-62 | 1961-62 | 1961-62 | 1961-62 | 1961-62 |
| | 1962-63 | 1962-63 | 1962-63 | ---- | ---- |

[a] Animals in these groups divided into two pens; one pen received approximately 15 ppm Se in ration, the other pen less than 2 ppm Se in ration. All bull calves received 15 ppm Se in ration.

Table 4. Results of Winter Feeding Trial, 1961-62

| Group | Treatment[a] | No. Animals | Average Daily Gain | Type Score[b] Initial | Type Score[b] Final | Condition Score[b] Initial | Condition Score[b] Final | Selenium Score[c] Initial | Selenium Score[c] Final |
|---|---|---|---|---|---|---|---|---|---|
| Bull Calves | Se | 13 | 1.21 | 9 | 9 | 9 | 9 | 1 | 5 |
| Yearling bulls | Se | 7 | 1.10 | 9 | 10 | 8 | 8 | 1 | 2 |
| | C | 6 | 0.85 | 9 | 9 | 8 | 7 | 0 | 0 |
| Heifer calves | Se | 7 | 1.05 | 9 | 7 | 9 | 7 | 0 | 4 |
| | C | 10 | 0.89 | 8 | 9 | 9 | 8 | 0 | 5 |
| Yearling heifers | Se | 9 | 0.75 | 8 | 8 | 8 | 8 | 0 | 1 |
| | C | 8 | 0.35 | 7 | 10 | 7 | 9 | 0 | 2 |
| Two-year-old heifers | Se | 7 | 0.46 | 7 | 8 | 7 | 6 | 1 | 1 |
| | C | 6 | 0.33 | 7 | 10 | 8 | 9 | 1 | 3 |

[a] Se = 15 ppm Se in ration; C = less than 2 ppm Se in ration.

[b] Ranked on a scale from 1-15, with 1 being most desirable.

[c] Ranked on a scale from o-12, with 0 indicating no symptoms of selenium poisoning.

Table 5. Results of Winter Feeding Trial, 1962-63

| Group | Treatment[a] | No. animals | Average Daily Gain | Type score[b] Initial | Type score[b] Final | Condition score[b] Initial | Condition score[b] Final | Selenium score[c] Initial | Selenium score[c] Final |
|---|---|---|---|---|---|---|---|---|---|
| Bull calves | Se | 10 | 0.93 | 9 | 9 | 8 | 9 | 1 | 1 |
| Yearling bulls | Se | 6 | 0.51 | 10 | 11 | 9 | 10 | 3 | 2 |
| | C | 6 | 0.95 | 9 | 8 | 9 | 9 | 2 | 1 |
| Heifer calves | Se | 9 | 0.83 | 9 | 8 | 9 | 9 | 1 | 1 |
| | C | 9 | 0.76 | 9 | 9 | 9 | 9 | 1 | 1 |

[a] Se = 15 ppm Se in ration; C = less than 2 ppm Se in ration.
[b] Ranked on a scale from 1-15, with 1 being most desirable.
[c] Ranked on a scale from 0-12, with 0 indicating no symptoms of selenium poisoning.

Table 6. Semen Characteristics of Yearling Bulls, Winter Feeding Trial, 1961-62

| Time of Collection | No. animals | Treatment[b] | Percent Motility | Percent Alive | Percent Abnormal | Concentration, millions per cc. |
|---|---|---|---|---|---|---|
| Initial | 7 | Se | 41 | 59 | 28 | 299 |
| | 6 | C | 42 | 60 | 40 | 294 |
| | | C-Se[c] | 1 | 1 | 12 | - 5 |
| Final | 7 | Se | 34 | 72 | 40 | 668 |
| | 6 | C | 69 | 78 | 22 | 744 |
| | | C-Se | 35 | 6 | - 18 | 76 |

[a] Initial sample taken at beginning of feeding trial; final samples taken at end of trial. Initial values based on one test; final values based on average of two tests.
[b] Se = 15 ppm Se in ration; C = less than 2 ppm Se in ration.
[c] Difference observed between control group and selenium group for each semen trait.

Table 7. Semen Characteristics of Yearling Bulls, Winter Feeding Trial, 1962-63

| Time of Collection | No. animals | Treatment[b] | Percent Motility | Percent Alive | Percent Abnormal | Concentration, millions per cc. |
|---|---|---|---|---|---|---|
| Initial | 6 | Se | 50 | 85 | 17 | 585 |
| | 6 | C | 56 | 84 | 23 | 745 |
| | | C-Se[c] | 6 | - 1 | 6 | 160 |
| Final | 6 | Se | 55 | 83 | 21 | 682 |
| | 6 | C | 53 | 81 | 19 | 705 |
| | | C-Se | - 2 | - 2 | - 2 | 23 |

[a] Initial samples taken at beginning of feeding trial; final samples taken at end of trial. Each value based on average of two tests.
[b] Se = 15 ppm Se in ration; C = less than 2 ppm Se in ration.
[c] Difference observed between control group and selenium group for each semen trait.



Table 8. Performance of Sheep on Two Levels of Selenium

| Group[a] | No. ewes exposed to rams | No. ewes remaining at lambing | No. ewes lambing | Total no. lambs | No. twin pairs | Lamb death losses: Periparturient | Lamb death losses: 1 week to weaning[b] | No. lambs weaned | Corrected weaning weight |
|---|---|---|---|---|---|---|---|---|---|
| Se | 60 | 60 | 50 | 57 | 7 | 1 | 22 | 34 | 54 |
| C | 60 | 59 | 56 | 67 | 11 | 6 | 26 | 35 | 55 |

[a] Se = group wintered on seleniferous alfalfa hay and grazing a pasture relatively high in selenium; C = group wintered on non-seleniferous hay and grazing a pasture relatively low in selenium.
[b] Most death losses occurred during month prior to weaning, apparently due to predatory animals.

## REPRODUCTIVE STUDIES WITH BEEF CATTLE

Donald E. Ray

(Extracted from Animal Science Bulletin AS-64-9)

At the Reed Ranch Station a study is underway to evaluate the effect of season of breeding on reproductive performance. This study was designed to alleviate some of the detrimental effects of selenium poisoning on reproduction, as the Reed Ranch Station was established to study selenium poisoning (alkali disease) in beef cattle. The average percent calf crop (49%) is indicative of the detrimental effect of selenium ingestion on reproduction. A recent summary of this study, covering results from 1958-1962, indicated that early breeding (starting May 1) resulted in an improvement in percent calf crop over late breeding (starting mid-July). A 60% calf crop was dropped in the early group, whereas only 38% was obtained in the late group.

The work outlined above will be continued until sufficient data are collected for meaningful analyses. If funds and facilities become available, the basic studies at Brookings will be expanded to provide for a more comprehensive research program in reproduction of beef cattle.

## CATTLE GRUB CONTROL

The work on cattle grub control at Reeds Ranch, Presho, parallels that done at the Antelope Range Station and at the Range Field Station, Cottonwood. This work is reported in the section for Antelope Range in this circular. (See page 7).

## TREE PLANTINGS AT REED RANCH

Paul E. Collins

After several years of summer fallow, the first windbreak was planted in 1955. Because of several severe hail storms that spring, it was necessary to replace most of the trees the following year. By the end of the 1957 growing season overall survival reached a satisfactory 90%.

The windbreak is oriented mostly east to west and lies north of the farmstead area. Its length effectively protects the living area from northwest to northeast.

Spacing between rows is 10-12 feet. Spacing in the rows varies from 3 feet in the two border rows to 8 feet in most of the interior rows.

Tree growth and survival has been excellent in spite of the heavy soil conditions and the annual precipitation. Species used and performing satisfactorily are Tatarian honeysuckle, Chinkota elm, honeylocust, common lilac, Eastern Redcedar and ponderosa pine. The latter two have done exceptionally well and comprise four of the ten-row windbreak. In time these evergreen rows will be the heart of the protective qualities of this windbreak.